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TRANSACTIONS
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A KEY TO THE GENERA OF LARVAL CARABIDAE (COL.)

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Manuscript received 8th October, 1941.

Read 5th November, 1941.

WITH ONE HUNDRED TEXT-FIGURES.

EARLY in 1939 Prof. W. P. Hayes of Urbana, Ill., suggested that my key to the genera of larval CARABIDAE (1919, *Suppl. ent.* **8** : 3) should be translated into English and re-published in an American journal. Whilst it was felt that it would be useful to arrange for an English edition, it was also realised that in the twenty years which had passed since its publication so many alterations, improvements and additions to the key had become necessary that a plain translation and re-publication of the 1919 paper would no longer suffice. I therefore decided to recast the key and to include genera available in the United States National Museum besides the material of the British and Copenhagen Museums and my own collection. Prof. Hayes at once wrote to Dr. C. F. W. Muesebeck, while in the meantime I had written to Drs. A. G. Böving and W. T. Anderson, asking for material from the United States National Museum. Thanks to these gentlemen and to Dr. E. A. Chapin, I soon obtained on loan a representative collection of 40 genera and subgenera, including 47 species of Carabid larvae, mostly North American. Dr. Kai L. Henriksen supplied me with some rare, mostly European, larvae not represented in the other material at hand. The collection of the British Museum (Natural History) was used freely through the courtesy of Dr. K. G. Blair. To these gentlemen as well as to the donors of the material now in the British Museum and in my own collection, as referred to in the list of material at the end of the paper, my sincere thanks are offered. Among the foremost of those to whom my thanks are due, I wish to mention Hr. E. Rosenberg, Mr. J. C. M. Gardner and Signor L. Boldori, who during their prolonged studies on larval CARABIDAE did everything possible to keep me informed of the results of their studies on the classification of these larvae and sent specimens of the more important genera as a present, in exchange, or on loan. The effect of this generous collaboration will be evident at many points in the present paper. I am indebted to my wife for a great deal of help in finishing the manuscript.

The key published in 1919 included 64 genera and subgenera, of which I had then not seen 34. The genus *Demetrias* was added in an abbreviated and improved key to the Central European genera as far as then known (1920, *Ent. Jahrb.* **1921** : 128). Numerous contributions have since been made by various authors, the most important being those by Gardner on Indian Carabid larvae (1927–38, *Indian Forest Rec.*, *Ent.* **13** (2) : 63–67; **16** (4) : 91–95; **17** (8) : 12 p.; (n.s.) **3** (8) : 149–156 and the most comprehensive one, 1936 *loc. cit.* (n.s.) **2** : 181–195), by Jeannel on Trechini, and Boldori mainly on Trechini (cited under the tribes concerned) and Böving and Craighead on the general classification of Carabid larvae (1931, *Ent. amer.* (n.s.) **11** : 18). For practical use a key in Russian was worked out from the existing literature by Znojko (1929, *Plant Prot.* **6** : 335). The genus *Pogonus* was there added to those previously known. Other contributions are referred to in the list of material under the group concerned, but they are only cited so far as it has been deemed appropriate actually to use them in the preparation of these keys, and so far as they are not contained in the world catalogue (Csiki, 1927–33, CARABIDAE *in* Junk-Schenkling, *Coleopterorum Catalogus*). In the present paper I report on 165 genera and subgenera, of which 28 have had to be incorporated from published sources. The genera which I have not seen are marked with an asterisk (*).

The keys are concerned with the characters of tribes, genera and, to some extent, subgenera. Descriptions of the species available have not been added, as really useful descriptions would have at least doubled the space required, but, in a few cases, striking characters are mentioned in the list of material. In larval taxonomy questions of priority are not normally involved. Therefore, detailed specific descriptions of larvae are, in my opinion, seldom called for, and time and printing space can more usefully be devoted to comparative treatment. Moreover, research on a world-wide basis on the larvae of a certain group will at present result in much safer and more final conclusions for the classification of tribes and genera than for that of species, of which necessarily the available proportion will be much smaller. Thus the species studied for the present paper may amount to about 2% of the described species of adults, whereas the genera and subgenera distinguished are 10% of those based on the adults (if the subgenera of *Carabus* are disregarded), and the tribes almost 50%.[1]

The relatively small proportion of species of which the larvae are available at present makes it imperative, in my opinion, to base a larval classification on as many characters as possible, as it is impossible to foresee which of the characters will retain their present diagnostic importance, after more complete material has been accumulated.

Since specific descriptions are omitted from this paper, a list of the species and specimens studied, or references to the literature, is given at the end. Similar lists have been published in several of my more recent reports on beetle larvae, and it may be desirable shortly to comment on these lists, which contain the data that cannot well be included in the keys. It is obviously necessary to indicate which particular species, what number of species and specimens and which stages have served for the definition of a genus. It is also desirable to state in which collection the specimens studied may be found, and it is often indispensable to comment on the method of identification or on the literature. The head-widths, on the use of which some remarks are made at p. 6, are also given in the list. Besides these data of more technical importance, this part also contains the geographical and ecological localities and the date of capture for each larva. It thus presents a relatively large collection of ecological and phenological data, much of which is new, particularly that concerning the occurrence of the larval instars in the various months of the year.

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[1] Of the following tribes the larval characters are unknown :—CARABINAE : Pamborini, Hiletini, Opisthiini, Trachypachyini, Metriini, Cicindini, Nototylini, Promecognathini, Enceladini, Siagonini, Migadopini. HARPALINAE piliferae : Apotomini, Nomiini, Zolini, Melaenini (see p. 63). HARPALINAE impilae : Pogonopsini, Perigonini, Cymbionotini, Cuneipectini, Agonicini, Idiomorphini, Zacotini, Peleciini, Disphaericini, Amorphomerini. HARPALINAE truncatipennes : Nematotarsini, Corsyrini, Graphipterini, Pentagonicini, Hexagoniini, Agrini, Helluodini, Euchilini. PSEUDOMORPHINAE. Most of these tribes consist of only one or two genera.

Diagnostic Characters of the Carabid Larvae: Legs consisting of five joints (coxa, trochanter, femur, tibia, tarsus) and one or two claws, *i.e.* with two joints and the claw(s) after the knee (figs. 40, 41, 42). Labrum and clypeus wholly fused with frontal piece. Mandibles without a suctorial channel, without a prostheca and with a single cutting edge (not two dentate ones, delimiting a groove as in *Noterus*). Maxillae (figs. 46–50) with the cardo very short, formed by two half-rings, which lie in the same axis as the stipes, outer lobe inserted on stipes. No gills or swimming fringes. Eighth pair of abdominal spiracles subequal in size to the others and in the same sublateral position (figs. 70–72, 75–85); ninth and tenth abdominal segments distinct.

These characters are strictly diagnostic of the larvae of CARABIDAE. The CICINDELINAE, which are often regarded as a separate family and which are not included in this paper, can be distinguished from the rest of the CARABIDAE by the strong, movable scansorial hooks on the dorsum of the fifth abdominal segment and by the connate palpiger and basal joint of the outer lobe. The PAUSSIDAE, as far as known, differ from the CARABIDAE by the prostheca of the mandibles and the smaller number of segments of the legs. It may, however, be assumed that the more primitive genera or first-stage larvae of the PAUSSIDAE will deviate to a lesser degree, or may even work out as Ozaenini in the key.

It will be difficult to recognise from the characters stated above, and from those in the keys, full-grown larvae of *Brachinus* and it will, indeed, be impossible to identify full-grown larvae of certain species of *Lebia* (*L. scapularis* Fourcroy) which are semi-parasitic on beetle-pupae. These third-stage larvae of *Lebia* live in a cocoon with only the head protruding and embedded in their prey, their legs consist of only two or three joints and a claw, the mouth-parts are very stout, and some of the joints of antennae and mouth-parts are fused.

General characters of the Carabid Larvae: Head directed forward or slightly upward, head-capsule formed by paired parietalia which are contiguous in a single ventral gular suture (figs. 5, 8, 94) and usually on posterior part of dorsum in an epicranial suture (figs. 3, 4, 16, etc.). In front of the latter the parietalia enclose a frontal piece (figs. 5, 17, etc.). The median part of the front margin of the latter is usually called nasale (*na* figs. 4, 9, 29; mesolabrum Lapouge), and the lateral parts are referred to as adnasalia (*ad* figs. 4, 9, 29; exolabrum Lapouge) in this paper. The neck may be absent or defined by a simple constriction (figs. 3, 4, 22) or a transverse, curved groove on the lateral surface, which is usually emphasised by a cervical keel (figs. 9, 11, 12, 23) along the posterior margin of the groove. This cervical keel is of considerable systematic importance. Ocelli six, never more,[2]

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[2] An abnormal seventh ocellus on one side has been found in a specimen of *Scarites* from Ukerewe.

sometimes fewer or none. Antennae (fig. 51) four-jointed, in a few genera (*Tefflus*, some Pterostichini) with an additional short joint at base (figs. 21, 56), sometimes the second and third joints fused (Anthiini, fig. 16), the third joint usually with a sensorial appendage on exterior side of apex (figs. 4, 12, 56). Mandibles more or less falciform or subtriangular (figs. 10–12, 59, Harpalini, Zabrini, Amarini), almost always with a retinaculum, usually with a subbasal penicillus on cutting edge (figs. 57–59). Maxillae, when seen from the side, inserted approximately level with mandibles (*i.e.*, ventral mouth-parts not retracted, fig. 23); stipes more or less rectangular, very seldom with a lobiform hairy process at interior side of apex (fig. 16, Anthiini), inner lobe absent (figs. 46, 48, 49) or present in shape of a coniform to styliform chitinous process with or, seldom, without a single seta (figs. 47, 50, 52, 55); outer lobe two-jointed, palpiform, very seldom the basal segment fused with stipes and hairy (fig. 17, Helluonini), palpiger [3] of the shape of a palpal segment, palpi usually three-jointed, seldom the third joint subdivided into two jointlets (fig. 48 Loricerini, fig. 49 Trechini). Labium (figs. 60–62) with a mentum [4] of almost always inverted trapezoidal form, at its apex with a usually small, chitinous, bisetose ligula and two-jointed palpi (the second joint subdivided in *Loricera*, most Trechini—fig. 49—and many Chlaeniini—fig. 62). Dorsum of the segments covered by a single, large tergite, which is divided by a very fine, pale median line, very rarely more broadly divided in middle (Orthogoniini) or absent. Abdomen formed by ten segments, the ninth usually with a pair of dorso-apical appendages, the cerci,[5] tenth usually tubular, acting as a proleg and often armed with a pair of protrusible tubes (fig. 71) which may be adorned with chitinous smaller or larger crotchets (figs. 81, 86, 88). Lateral abdominal sclerites (figs. 70, 88, 89, etc.), two on each side, an epipleurite (sometimes divided into two separate sclerites, fig. 75) to the outer side of the tergite and the annuliform spiracle, and a hypopleurite on latero-ventral surface of the abdomen. Ventral surface (figs. 87–89) with five sclerites, an anterior ventrite and two pairs of postventrites [6] behind it; these are usually more or less fused on the eighth

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[3] In my earlier papers I counted the palpiger as the first joint of the palp. Owing to the particular relations of this joint with the outer lobe in Cicindelinae, Histeridae, Hydrophilidae and other groups, I now return to Schiödte's way of counting the palpiger separately and regarding the normal palpus of Carabidae as three-jointed.

[4] The morphology of the labium of the larva of *Carabus* has been discussed by Bengtsson (1927, *Lunds Univ. Årsskr.* (n.f.) (2) **24** (2) : (20)). Anderson's interpretation (1936, *Smithson. misc. Coll.* **95** : 13) is not accepted in the present paper for the reasons explained in 1938, *Trans. R. ent. Soc. Lond.* **87** : 4.

[5] I consider it very doubtful whether new discoveries or theories of a comparative morphological character should always result in a change of terms in systematic descriptions. In the case of the cerci of the beetle-larvae (recently often called pseudocerci or urogomphi), however, even the morphological evidence points to their homology with the cerci on the tenth abdominal segment of primitive insects. In some larvae of Carabidae these appendages are inserted behind the ninth tergite and separated from it by a narrow membranous zone, *e.g.* in Nebriini (fig. 69), Panagaeini (fig. 80) and many Chlaeniini (fig. 79). In some of the latter the cerci are multiannulate and thus quite like those of primitive insects, except for the fact that they are inserted behind the ninth and not on the tenth segment. However, even in primitive insects, e.g. *Periplaneta orientalis* L., the cerci are inserted near the base of the segment between tergite and ventrite. If these two sclerites are prolonged and strongly convex, so as to form the cylindrical, narrow tenth abdominal segment of the larvae of Carabidae, which acts as an auxiliary leg, and which still usually shows the lateral suture between tergite and ventrite (figs. 69, 70, 78), the cerci must automatically be pushed forward on to the membrane between the ninth and tenth segments, as in *Nebria* etc. This condition, however, is in the single family Carabidae connected by every transition with the fixed coniform cerci of *Cychrus*, which are only spine-shaped extensions of the ninth tergite, exactly as in *Cryptophagus* and other Polyphaga.

[6] The terms " ventrite " and " postventrite " are introduced to replace Schiödte's terms sternum and sternella, as Sir Guy Marshall drew my attention to the fact that in insects with their marked distinction between thorax and abdomen the expression sternum should be reserved for the ventral parts of the thorax, whereas for the abdomen " ventrites " would be adequate. This seems to be advisable from a morphological as well as from a practical

and wholly fused on the ninth and tenth segments, seldom partly fused on other segments. A pair of minute praeventrites is often visible in well-extended larvae (*pr.* in figs. 71, 88).

Besides identification from systematic characters (*determinatio ex systemate*) that by breeding from adult to larva (*det. ex ovipositione*) or larva to adult (*det. ex evolutione imaginis*) will supply reliable working material. In the latter case individual breeding is necessary, not only because of the carnivorous habits of these larvae but, much more important, in order to avoid misidentifications resulting from the breeding of a lot of larvae, the mixed nature of which was not realised, or from strange larvae introduced inadvertently with earth or plants (see *Drypta dentata* in list of material p. 80). In many cases, however, more indicative identifications will have to be used, and there is little that is objectionable in this procedure, so long as it is made clear that the larva has not been bred. If a preserved pupa with last larval skin is available, it may be possible to identify the exuvia from the characters of the adult recognisable in the pupa (*det. ex futura imagine*). Other indications may be given *ex patria*, *ex domicilio*, *ex societate imaginis*, etc. I have discussed these possibilities in one of my early papers (1922, *Ent. Jahrb.* **1923** : 102), but there is one indication which needs some further comment, that of size (*det. ex magnitudine*).

Size in holometabolous insects is perhaps the only larval character directly correlated with the characters of the adult. By itself, however, it can only be used in a very restricted way, as a small larva may either be a young instar of a large beetle or a full-grown small form. Moreover, the length of a larva is very much influenced by its state of nourishment or impending transformation. For these reasons, it can only be said that a well-extended larva of a certain size cannot belong to an adult of less than roughly two-thirds that length (e.g. *Feronia madida* adult 13–17 mm., larva up to 25 mm.). If the larva belongs to a systematic group of very slender adults, the adult could not be shorter than four-fifths or five-sixths of its length. Thus, the third-stage larva of *Clivina fossor* L. measures 6·7 mm., whereas the length of the adult is 5·5–6·3 mm.

A much greater use of the size is possible, as soon as the larval instar[7] is known. In many cases, the generic identification of a larva will supply a clue to the stage concerned. Moreover, the first larval stage is recognisable by fewer hairs, a proportionately larger head, and above all by the egg-bursters, which are very seldom absent.[8] These organs were discussed at length in a previous paper (1925, *Z. wiss. Zool.* **126** : 622) and are found in Carabid larvae along the inner side of the hind part of the frontal sutures (fig. 4). They are either keel-shaped, more or less abruptly terminating anteriorly in a short spine (Carabini, Nebriini, Notiophilini fig. 4, Omophronini, Elaphrini, Helluonini, Anthiini, Dryptini, Broscini, Pterostichini, some Chlaeniini, Panagaeini, Licinini, some Amarini, Zabrini fig. 69) or thorn-shaped. In the latter case the spines may be simple and paired (Lebiini: *Cymindis*, *Parena*, *Calleida*, *Onota* or *Otoglossa*, *Oecornis*, some Harpalini: *Barysomus* ?, some Amarini, fig. 67), a single spine

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point of view, as it dispenses with the continuous repetition of the word abdominal. Correspondingly the term tergites always refers to the dorsal shields of the abdomen and nota to those of the thorax.

[7] The CARABIDAE pass through three larval stages so far as is known. Two stages only, probably an individual abnormality, were recorded by me in a single larva of *Amara ingenua* Duftschmid (1924, *in* Blunck, *Syllabus Insektenbiol.* **1** : 28), two stages only seem to be indicated by the material of *Dicheirotrichus*, and some Helluonini may perhaps have more than three larval stages (see p. 81).

[8] Apparently in all the Trechini, *Brachinus* and perhaps some Helluonini.

on median line (some Brachinini : *Pheropsophus* fig. 70), a paired row of spines (most Harpalini fig. 68, some *Chlaenius* with filiform cerci, some Bembidiini : *Asaphidion* [9]—sometimes with only two pairs of spines—fig. 66—as also in *Arsinoë*—fig. 14—and some *Calleida*) or a paired area of irregularly arranged spinules (fig. 65 *Bembidion*). Apart from the exceptions mentioned in note 8 all the larvae without egg-bursters must, then, belong to the second and third larval stages. In many cases two stages will be available, which will usually allow definite determination of the instars.

In studying several stages of one species it has been observed that the growth-factor is practically equal from the first to the second and from the second to the third stage,[10] and, moreover, that this factor varies to only a moderate extent within the whole family or most of it (see table, factors *a* and *b*). In the same way a factor can be worked out, which correlates the size of the larva with that of the adult. The length of the adult is a rather clearly defined measurement, but that of the larva cannot be used for the reasons explained above. A very suitable measurement instead is the width of the head, which is subject only to a very slight degree of change within the duration of a larval stage.[11] The factor which brings the head-width of the larva up to the length of the adult must naturally be expected to differ in large-headed larvae, such as those of the Harpalini, especially *Harpalus rufipes*, and small-headed ones, such as those of Licinini, but it will as a rule be approximately alike in larvae of a subgenus, genus or even a tribe. Thus, after finding the genus or group of genera, one will be able to decide from a first-stage larva what must be the approximate size of the adult. A larva, which is not of the first stage, will in the same way lead to two possible sizes for the adult, of which one will often be excluded as too large or too small for the genus, or group of genera, in the locality of the larva. The values of these factors for the different stages of a number of genera and species are listed in the table p. 8. I have found these factors an important aid in identifying larvae, as will be seen from some of the remarks in the list of material.

The factors *a* and *b* vary between 1·0 and 1·8, as far as is known, and if extreme cases, due to single specimens, are excluded and the greater deviations between *a* and *b* in one and the same species are eliminated by using the average of the two values, 1·3–1·4 becomes still more the predominant growth-factor in Carabid-larvae. As to factors *c*, *d*, and *e*, the large *c* of the Brachinini and *Arsinoë* stands out and is doubtless to be explained by the ectoparasitic habits of the larvae. The number of eggs is obviously large and their size proportionately small, as a large proportion of the first-stage larvae may be expected not to succeed in finding their hosts and to perish. In other cases (e.g. *Sphodrus* and its relatives) the large factors *c*–*e* are obviously caused by the slenderness of the adult, as the small values in Harpalini are due to the stout build of the adults and the wide head of the larvae.

The classification of the ground-beetles seems to be fairly well established for adults as well as larvae and seems to be practically congruent in the two stages, if the usual[12] system of the adults, as accepted, *e.g.* by Ganglbauer (1892, *Käfer Mitteleur.* 1), Jacobson (1905, [*Col. Russia W. Europe*]), Csiki (1927–33, CARABIDAE *in* Schenkling-Junk, *Col. Cat.*) and Andrewes (1929, *Fn. Brit. India, Carabidae* **1** : 47; 1935, *loc. cit.* **2** : 1), and my former (1919) and present key to the larvae are compared.

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[9] Boldori, 1939, *Boll. Soc. ent. ital.* **71** : 102, 110 figs. 6 and 7.

[10] Gardner 1933, *Indian Forest Rec.* (*Ent.*) **17** (8) : 1–3. Actually the relative growth, of course, must diminish with the duration of growth as in other animals, but this tendency is not very conspicuous, where only two steps of larval growth can be checked as in CARABIDAE.

[11] Emden, 1929, *Schrift. phys. ökon. Ges. Königsberg* **66** (2) (*Zehlau-Heft*) : 276, note 3. Gardner (1933, *Indian Forest Rec.* (*Ent.*) **17** (8) : 1) used the length of the frontal piece. As this is inclined forward in undissected larvae, its exact measure is often difficult to obtain, and, since a large number of such larvae have had to be measured for this paper, the head-width has been deemed more convenient.

The weak spot in the present system of classification of larvae is the subfamily CARABINAE, for which no common character has yet been found, so that it is necessary to separate these tribes singly. However, they have at least a negative character in common, which, though not being suitable for determination, nevertheless indicates that the group is different from the rest. This negative character is the instability of the inner lobe, which is present or absent in very closely related genera in this group. *e.g.*, respectively in *Nebria* and *Leistus*, *Blethisa* and *Elaphrus*, *Storthodontus* and some *Scarites*, *Clivina* and *Dyschirius*.

The huge remainder of the larvae of CARABIDAE is divided into two groups according to the presence or absence of the maxillary inner lobe. This is, in my opinion, still the most important character in the classification of these larvae in spite of a few drawbacks, which have become apparent during the last twenty years. All the groups centering round Harpalini, Pterostichini, Chlaeniini etc., *i.e.*, the HARPALINAE impilae (Emden, 1936, *Ent. Blätt.* **32** : 41 HARPALINAE with the elytra entire and without a seta in the mandibular scrobe) have in the larval stage a coniform inner lobe, whereas the HARPALINAE piliferae and truncatipennes are devoid of this chitinous cone. The Orthogoniini, which have often been regarded as Truncatipennes, cannot be separated from *Glyptus*—either as adults or larvae—which belongs near the Harpalini. Among the Harpalini impilae, however, the inner lobe becomes very small in *Calathus* (fig. 47) and some *Abacetus*, and is practically lost in *Diceromerus* (fig. 54) and absent in *Caelostomus*. There may be an actual relationship between the subtribe Drimostomina of the Pterostichini, to which the last two genera belong, and the Nomiini in the HARPALINAE piliferae, as suggested from adult characters by Tshitsherine (1902, *Hor. Soc. ent. ross.* **35** : 508). The small inner lobe of *Leptotrachelus* is particularly interesting. This genus is in the adult stage placed either in the tribe Ctenodactylini, or if the latter be united with it, in Colliurini, the elytra being more or less truncate in the latter tribe but complete in the former, though it is obviously related to the Colliurini. Bates (1883, *Biol. centr.-amer.* (*Coleopt.*) **1** : 152, 158) created the two groups Subtruncati and Obtusipennes for the adults of respectively Lachnophorini and Ctenodactylini, emphasising their intermediate position between Colliurini and Anchomenina.

The only, but the most puzzling, case, in which the inner lobe is present in HARPALINAE piliferae, a group which has otherwise lost this organ, is *Axonya*, a genus of Broscini. The lobe is quite well developed in this genus, no doubt of any kind as to the identification is possible, and the adult is an absolutely typical member of the Broscini. Perhaps the inner lobe may here be explained as an atavism, though this term is rather worn out. The adults of the Broscini, too, are one of the most puzzling groups of CARABIDAE, and I have recently found out that some of the genera (e.g. *Cnemacanthus*) even have the paramera

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[12] The other modern classification of the adults by Sloane (1923, *Trans. ent. Soc. Lond.* **1923** : 242) does not conform either to the present arrangement of the larvae or to that given by Böving and Craighead (1931, *Ent. amer.* (n.s.) **11** : 19), nor, so far as I can see, can it be imitated in the classification of the larvae. On the other hand, Böving and Craighead's classification does not follow either system of adults, nor does the study of more material confirm it, as the number of exceptions would be considerable.

Species	Head-width of									Length of adult	Factors[13]				
	1st-stage larva			2nd-stage larva			3rd-stage larva								
	min.	aver.	max.	min.	aver.	max.	min.	aver.	max.		*a*	*b*	*c*	*d*	*e*
Cychrus caraboides	—	—	—	—	1·81	—	—	—	—	15·5–20	—	—	—	9·8	—
Cychrus attenuatus	—	—	—	1·43	1·63	1·79	—	—	—	13–18	—	—	—	9·5	—
Scaphinotus debilis	—	—	—	—	1·43	—	—	1·84	—	9–12	—	1·3	—	7·4	5·7
Sphaeroderus lecontei	—	—	—	—	—	—	—	2·25	—	13·5–16	—	—	—	—	6·6
Ceroglossus suturalis	—	—	—	—	—	—	2·62	2·68	2·72	15–20	—	—	—	—	6·5
Calosoma sycophanta	—	—	—	—	—	—	—	3·48	—	24–30	—	—	—	—	6·0
Calosoma scrutator	—	—	—	—	3·01	—	—	4·2	—	25–36	—	1·4	—	10·1	7·3
Calosoma inquisitor	—	—	—	—	—	—	—	2·86	—	16–21	—	—	—	—	6·5
Carabus auratus[14]	1·92	—	2·13	—	2·65	—	—	3·56	—	22–27	1·3	1·3	12·1	9·2	6·9
Carabus cancellatus	—	—	—	1·85	—	1·87	2·51	—	2·69	19–24	—	1·4	—	11·6	8·3
Carabus nemoralis	1·69	1·79^{16}	2·06	2·23	2·30^{5}	2·35	2·79	2·94^{13}	3·17	20–26	1·3	1·3	12·8	10·0	7·8
Carabus granulatus	—	1·26	—	1·60	1·68^{3}	1·81	2·09	—	2·23	17–23	1·3	1·3	15·9	11·9	9·3
Carabus ulrichi	2·2	—	2·3	—	—	—	—	—	—	26–30	—	—	12·4	—	—
Carabus glabratus	—	1·83	—	2·13	2·17^{3}	2·21	—	2·69	—	22–26	1·2	1·2	13·1	11·1	8·9
Carabus convexus	—	—	—	—	—	—	1·81	—	1·9	15–18	—	—	—	—	8·9
Carabus hortensis	1·74	1·8^{4}	1·85	—	2·3	—	—	2·79	—	23–30	1·3	1·2	14·7	11·5	9·5
Carabus nitens	—	—	—	—	—	—	—	1·67	—	13–18	—	—	—	—	9·3
Carabus problematicus	—	—	—	2·27	2·36^{7}	2·48	—	—	—	22–32	—	—	—	11·4	—
Carabus auronitens	—	—	—	—	—	—	3·11	3·16^{3}	3·21	18–26	—	—	—	—	7·0
Carabus violaceus	—	1·83	—	—	—	—	3·3	3·4^{4}	3·6	18–34	—	—	14·2	—	7·6
Carabus coriaceus	2·4	2·68^{6}	2·8	—	3·5	—	4·3	4·41^{8}	4·6	34–40	1·3	1·3	13·8	10·6	8·4
Eurynebria complanata	—	—	—	—	2·62	—	—	3·28	—	17–23	—	1·3	—	7·6	6·1
Nebria brevicollis	0·8	0·87	0·91	1·15	1·24	1·34	1·57	1·68	1·81	9–14	1·4	1·4	13·2	9·3	6·8
Nebria hemprichi	—	—	—	—	—	—	—	2·13	—	13–15	—	—	—	—	6·6
Nebria andalusiaca	0·84	—	0·87	1·19	—	1·26	1·74	—	1·78	11–13	1·4	1·4	14·0	9·8	6·8
Nebria gyllenhali	0·91	—	0·94	—	1·15	—	1·53	1·63	1·73	9–12	1·2	1·4	11·4	9·1	6·4
Nebria livida	—	0·98	—	—	—	—	—	2·06	—	14–16	—	—	15·3	—	7·3
Nebria jockischi	—	1·15	—	—	—	—	(1·74)	—	2·06	13–15	—	—	12·2	—	7·4
Nebria angusticollis	—	—	—	—	0·98	—	—	—	—	7·5–9·5	—	—	—	8·7	—
Nebria heeri	—	—	—	—	—	—	1·33	1·35	1·36	8–9·5	—	—	—	—	6·5

Leistus spinibarbis	—	—	—	—	1·22	—	—	—	—	9–11	—	—	—	8·2	—
Leistus ferrugineus	—	—	—	0·83	0·85	0·88	0·98	1·04	1·08	6·5–7·5	—	1·2	—	8·2	6·7
Leistus terminatus	0·61	0·63	0·66	—	0·80	—	0·92	1·00	1·05	6·5–7·5	1·3	1·3	11·1	8·8	7·0
Notiophilus biguttatus	0·48	0·49	0·50	0·50	0·56	0·61	0·79	0·85	0·87	5–5·5	1·1	1·5	10·7	9·4	6·2
Physea setosa	—	—	—	—	—	—	—	2·00	—	13–15	—	—	—	—	7·0
Omophron limbatum	—	0·52	—	—	—	—	—	1·08	—	6	—	—	11·5	—	5·6
Omophron rothschildi	—	—	—	—	0·87	—	1·26	1·30	1·34	7·5–8·5	—	1·5	—	9·2	6·2
Loricera pilicornis	—	—	—	0·73	—	0·77	1·08	1·10	1·15	7–8	—	1·5	—	10·0	6·8
Elaphrus riparius	—	0·49	—	0·68	—	0·71	0·99	1·05	1·08	6·5–7·5	1·4	1·5	14·3	10·1	6·7
Elaphrus cupreus	—	—	—	—	—	—	1·05	1·12	1·15	7·6–9	—	—	—	—	7·4
Blethisa multipunctata	—	—	—	—	—	—	—	1·53	—	11–13	—	—	—	—	7·8
Storthodontus amplipennis	—	3·9	—	—	—	—	—	—	—	40–50	—	—	11·5	—	—
Dyscherus praelongus	—	—	—	—	4·4	—	—	—	—	31–41·5	—	—	—	8·2	—
Scarites semicarinatus	—	—	—	—	2·48	—	—	—	—	16–22	—	—	—	7·7	—
Scarites cyclops	—	—	—	—	—	—	—	6·3	—	28–42	—	—	—	—	5·6
Scarites sulcatus	—	—	—	—	4·2	—	5·4	—	6·2	28–43	—	1·4	—	8·5	6·1
Scarites quadriceps	—	—	—	2·30	2·39	2·44	—	—	—	19–29	—	—	—	10·0	—
Scarites abbreviatus	—	—	—	—	—	—	—	3·24	—	18–28	—	—	—	—	7·1
Scarites molossulus	—	—	—	2·58	—	2·69	4·5	—	4·7	26–33	—	1·7	—	11·2	6·4
Clivina fossor	—	—	—	—	—	—	—	0·84	—	5·5–6·2	—	—	—	—	7·0
Dyschirius arenosus	—	—	—	—	0·45	—	—	—	—	4–5	—	—	—	10·0	—
Perileptus areolatus	—	0·26	—	—	0·38	—	—	—	—	2·6–2·8	1·5	—	10·4	7·1	—
Aepopsis robini	—	—	—	—	—	—	0·40	—	0·42	2·5	—	—	—	—	6·1
Typhlotrechus hauckei	—	—	—	—	0·98	—	—	—	—	7–8	—	—	—	7·7	—
Typhlotrechus hacqueti	—	—	—	—	—	—	—	1·05	—	6·5–7	—	—	—	—	6·4
Speotrechus humeralis	—	—	—	—	0·68	—	—	0·80	—	5–5·5	—	1·2	—	7·7	6·6
Trechus pulchellus	—	—	—	—	0·31	—	—	—	—	2·5–3·5	—	—	—	9·7	—
Asaphidion flavipes	—	0·39	—	—	—	—	—	0·84	—	4–4·5	—	—	10·9	—	5·1
Bembidion fasciolatum	0·40	0·41	0·42	—	0·63	—	—	—	—	5·5–6	1·5	—	14·0	9·1	—
Bembidion testaceum	—	0·35	—	—	—	—	—	—	—	4·5–5·5	—	—	14·3	—	—
Bembidion dalmatinum	0·40	—	0·41	—	—	—	—	—	—	5–6	—	—	13·6	—	—
Bembidion laterale	—	—	—	—	—	—	—	0·70	—	3–4	—	—	—	—	5·0
Tachys nanus	—	—	—	—	—	—	—	0·54	—	2·8–3	—	—	—	—	5·4
Tachys vivax	—	—	—	—	—	—	—	0·43	—	2·2–2·5	—	—	—	—	5·5
Tachys incurvus	—	—	—	—	—	—	—	0·41	—	1·7–2·3	—	—	—	—	4·9
Pogonus luridipennis	—	—	—	0·94	1·02	1·08	1·40	1·44	1·50	6–8·5	—	1·4	—	7·1	5·0
Broscus cephalotes	1·74	1·93	2·02	2·50	2·66	2·83	3·6	3·68	3·8	17–22	1·4	1·4	10·1	7·3	5·3
Axonya championi	—	—	—	—	—	—	—	1·47	—	9·5–11	—	—	—	—	7·0

Species	Head-width of									Length of adult	Factors [13]				
	1st-stage larva			2nd-stage larva			3rd-stage larva								
	min.	aver.	max.	min.	aver.	max.	min.	aver.	max.		*a*	*b*	*c*	*d*	*e*
Deltomerus corax	—	—	—	—	1·20	—	1·88	—	2·18	11·5–12	—	1·7	—	9·8	5·8
Diplous aterrimus	—	—	—	—	—	—	—	1·80	—	9–13	—	—	—	—	6·1
Caelostomus picipes	—	—	—	—	0·75	—	—	—	—	6	—	—	—	8·0	—
Diceromerus orientalis	—	—	—	—	—	—	—	1·80	—	8·5–9·5	—	—	—	—	5·0
Cratocerus sulcatus	—	—	—	—	0·59	—	—	—	—	4·25–4·5	—	—	—	7·5	—
Sphodrus leucophthalmus	—	1·26	—	—	—	—	3·23	—	3·53	20–40	—	—	23·8	—	8·9
Pristonychus terricola	—	—	—	—	1·37	—	1·88	2·04	2·19	13–17	—	1·5	—	10·9	7·4
Laemostenus complanatus	—	—	—	—	1·39	—	—	2·14	—	12·5–15	—	1·5	—	9·9	6·4
Laemostenus carinthiacus	0·79	0·83	0·86	—	1·27	—	—	1·89	—	14–16	1·5	1·5	18·1	11·8	7·9
Laemostenus boldorii	—	0·84	—	—	—	—	1·69	1·85	1·95	12·5–15	—	—	16·4	—	7·4
Calathus fuscipes	—	0·84	—	1·46	1·50	1·54	1·59	1·66	1·76	10–14	1·8	1·1	14·3	8·0	7·2
Calathus erratus	—	0·71	—	—	—	—	—	—	—	8–12	—	—	14·1	—	—
Calathus micropterus	—	—	—	—	—	—	—	1·07	—	7–8	—	—	—	—	7·0
Odontonyx rotundatus	—	0·53	—	—	—	—	—	0·91	—	6–7	—	—	12·3	—	7·1
Agonum ruficorne	—	—	—	—	—	—	—	1·13	—	6·5–9	—	—	—	—	6·9
Agonum assimile	—	—	—	—	—	—	—	1·71	—	10–12·5	—	—	—	—	6·6
Agonum moestum	—	—	—	—	—	—	1·22	—	1·26	7·5–8·5	—	—	—	—	6·5
Agonum ericeti	—	0·50	—	—	—	—	—	—	—	6	—	—	12·0	—	—
Abax ater	—	1·30	—	1·87	2·03	2·13	2·72	2·91	3·16	18–22	1·6	1·4	15·4	9·9	6·9
Abax parallelus	—	—	—	—	1·53	—	—	—	—	14–17	—	—	—	10·1	—
Molops piceus	—	—	—	—	1·47	—	—	—	—	12–15	—	—	—	9·2	—
Evarthrus sigillatus	—	—	—	—	—	—	2·34	—	2·42	14·5–17·5	—	—	—	—	6·7
Evarthrus sodalis	—	—	—	—	—	—	2·20	—	2·34	17·5–18·5	—	—	—	—	7·9
Trichosternus vigil	—	—	—	—	2·37	—	—	—	—	20–23	—	—	—	9·1	—
Feronia globosa	—	—	—	—	—	—	—	2·51	—	15–17	—	—	—	—	6·4
Feronia madida	1·22	—	1·25	1·50	1·68	1·84	2·23	2·41	2·57	13–17	1·4	1·4	12·1	8·9	6·2
Feronia lucublanda	—	—	—	1·29	1·35	1·39	—	1·66	—	10–14	—	1·2	—	8·9	7·2
Feronia gebleri	—	—	—	—	—	—	2·62	—	2·90	15–17·5	—	—	—	—	5·9
Feronia unctulata	—	—	—	—	0·84	—	—	—	—	7–7·5	—	—	—	8·6	—
Feronia lustrans	—	—	—	—	—	—	—	1·78	—	9·5–11·5	—	—	—	—	5·9

Feronia superciliosa	—	—	—	—	—	—	1·99	2·06	2·20	15	—	—	—	—	7·3
Feronia corvina	—	—	—	—	1·29	—	1·74	1·85	1·92	14–15	—	1·4	—	11·2	7·8
Feronia melanaria	—	—	—	1·67	1·80	1·99	2·37	2·55	2·76	13–17	—	1·4	—	8·3	5·9
Feronia oblongopunctata	—	0·80	—	—	—	—	—	—	—	9–12	—	—	13·1	—	—
Feronia stygica	—	—	—	—	1·73	—	1·95	—	2·09	14–16·5	—	1·2	—	8·8	7·5
Feronia diligens	0·42	0·43	0·44	—	—	—	0·87	0·93	1·08	5–6	—	—	12·8	—	5·9
Feronia nigrita	—	0·66	—	—	—	—	1·64	1·80	1·92	8·5–11	—	—	14·8	—	5·4
Feronia multipunctata	1·10	—	1·12	—	—	—	—	—	—	13–15	—	—	12·6	—	—
Feronia welensi	—	—	—	—	—	—	—	2·97	—	14–18	—	—	—	—	5·4
Feronia aethiops	—	—	—	—	1·47	—	—	2·50	—	12–14	—	1·7	—	8·8	5·2
Feronia muta	1·22	—	1·29	—	1·60	—	—	—	—	10–12·5	1·3	—	8·8	6·9	—
Feronia cristata	—	—	—	—	1·80	—	—	2·50	—	13–15	—	1·4	—	7·8	5·6
Feronia permunda	0·84	—	0·91	—	—	—	1·57	—	1·67	12–14	—	—	14·9	—	8·0
Zabrus tenebrioides	1·12	1·19	1·26	1·61	1·76	1·88	2·51	2·73	2·86	14–16	1·5	1·6	12·6	8·5	5·5
Zabrus crassus	—	—	—	—	—	—	—	3·07	—	12–13	—	—	—	—	4·1
Amara obesa	—	—	—	—	—	—	1·95	2·13	2·29	9–12	—	—	—	—	4·9
Amara equestris	—	—	—	—	—	—	1·43	1·53	1·61	8–10	—	—	—	—	5·9
Amara aulica	1·39	1·48	1·58	—	—	—	2·48	2·59	2·70	11–14	—	—	8·4	—	4·8
Amara convexiuscula	—	—	—	—	—	—	—	2·06	—	10–13	—	—	—	—	5·6
Amara gigantea	—	—	—	—	—	—	—	4·60	—	17–21	—	—	—	—	4·1
Amara similata	0·68	0·69	0·69	—	—	—	—	1·26	—	7·5–9·5	—	—	12·3	—	6·7
Amara musculus	—	—	—	—	—	—	1·00	1·10	1·20	4·7–5·7	—	—	—	—	4·7
Amara bifrons	—	—	—	—	—	—	1·05	1·11	1·20	5·5–6·5	—	—	—	—	5·4
Amara ingenua	—	1·13	—	—	—	—	—	1·95	—	9–10	—	—	8·4	—	4·9
Amara quenseli	—	—	—	—	—	—	—	1·22	—	5·5–8	—	—	—	—	5·5
Amara consularis	0·90	0·92	0·94	—	—	—	—	1·70	—	7–9	—	—	8·7	—	4·7
Amara fulva	—	—	—	—	1·31	—	1·60	1·74	1·84	7·5–9·5	—	1·3	—	6·1	4·6
Amara apricaria	—	—	—	—	—	—	1·27	1·38	1·43	6·5–7·5	—	—	—	—	5·1
Orthogonius schaumi	—	—	—	—	—	—	1·92	1·97	2·06	15–16	—	—	—	—	7·9
Orthogonius assmuthi	—	—	—	—	—	—	—	1·81	—	13–18	—	—	—	—	8·6
Dicheirotrichus pubescens	0·71	0·72	0·73	—	—	—	0·96	1·05	1·13	5·5–7·5	1·5		9·0		6·2
Anisotarsus sayi	—	—	—	—	—	—	1·43	1·54	1·65	9·5–10·8	—	—	—	—	6·6
Trichopselaphus subiridescens	—	—	—	—	—	—	—	1·37	—	7–9	—	—	—	—	5·8
Anisodactylus binotatus	—	—	—	—	1·67	—	—	2·13	—	11–13	—	1·3	—	7·2	5·6
Anisodactylus poeciloides	—	—	—	—	—	—	—	1·91	—	10–13·5	—	—	—	—	6·1
Amphasia interstitialis	—	—	—	—	—	—	1·65	1·74	1·82	8·5–10	—	—	—	—	5·3
Diachromus germanus	0·99	1·00	1·01	—	1·24	—	—	—	—	8–10	1·2	—	9·0	7·3	—
Euryderus zabroides	—	—	—	—	2·14	—	3·50	—	4·10	11–14·5	—	1·8	—	6·0	3·4

Species	Head-width of									Length of adult	Factors[13]				
	1st-stage larva			2nd-stage larva			3rd-stage larva								
	min.	aver.	max.	min.	aver.	max.	min.	aver.	max.		*a*	*b*	*c*	*d*	*e*
Cratacanthus dubius	—	—	—	—	—	—	2·48	—	2·51	7·5–9·8	—	—	—	—	3·5
Harpalus puncticollis	1·08	1·14	1·19	—	—	—	—	—	—	6–10	—	—	7·0	—	—
Harpalus azureus	—	—	—	—	1·47	—	—	—	—	7–9	—	—	—	5·4	—
Harpalus stictus	1·28	1·29	1·31	1·65	1·79	1·95	2·40	2·49	2·63	10–12·5	1·4	1·4	8·7	6·3	4·5
Harpalus rufipes	1·85	2·12	2·36	2·40	2·66	2·89	2·83	2·94	3·01	14–16	1·3	1·1	7·1	5·6	5·1
Harpalus calceatus	—	1·54	—	—	—	—	—	—	—	13–15	—	—	9·1	—	—
Harpalus compar	—	—	—	—	—	—	—	3·00	—	13–16·5	—	—	—	—	4·9
Harpalus rubripes	1·12	—	1·19	—	—	—	—	2·09	—	8–11	—	—	8·2	—	4·5
Harpalus honestus	1·05	—	1·08	—	1·50	—	—	—	—	7–10	1·4	—	8·0	5·7	—
Harpalus aeneus	1·19	1·33	1·47	1·40	1·63	1·76	1·91	2·31	2·59	9–12	1·2	1·4	7·9	6·4	4·5
Agonoderus lineola	—	—	—	1·05	1·15	1·24	1·56	1·64	1·78	7–8	—	1·4	—	6·5	4·6
Bradycellus rupestris	—	—	—	—	—	—	—	0·60	—	3·4–4·5	—	—	—	—	6·6
Stenolophus teutonus	—	—	—	—	—	—	—	1·05	—	5·5–6	—	—	—	—	5·5
Acupalpus exiguus	—	0·30	—	—	—	—	—	—	—	2–2·5	—	—	7·5	—	—
Chlaenius nigricornis	—	—	—	—	0·94	—	—	1·29	—	10–11·5	—	1·4	—	11·4	8·3
Chlaenius festivus	—	—	—	—	—	—	—	2·14	—	14·5–16	—	—	—	—	7·1
Chlaenius sericeus	—	—	—	—	—	—	1·84	—	1·91	12–16	—	—	—	—	7·5
Oodes heliopioides	—	—	—	—	—	—	1·20	1·24	1·28	7–8·5	—	—	—	—	6·3
Rembus laticollis	—	—	—	—	—	—	1·10	—	1·20	13–15	—	—	—	—	12·2
Dicaelus purpuratus	—	—	—	—	—	—	—	2·30	—	20–25	—	—	—	—	9·8
Licinus punctulatus	—	0·94	—	—	0·94	—	1·15	1·20	1·19	13–18	1·0	1·3	16·5	16·5	12·9
Licinus depressus	—	—	—	—	—	—	—	0·84	—	8–10	—	—	—	—	10·7
Panagaeus crux major	—	—	—	—	—	—	0·81	—	0·88	7·5–8	—	—	—	—	9·2
Tefflus muansanus	2·19	2·21	2·23	—	3·00	—	3·8	3·85	3·9	34	1·4	1·3	15·4	11·3	8·8
Tefflus corpulentus	—	—	—	—	4·70	—	—	—	—	47–54	—	—	—	10·7	—
Anaulacus fasciatus	0·50	0·51	0·52	—	0·65	—	0·91	—	0·94	5·5–6	1·3	1·4	11·3	8·8	6·2
Lobodontus trisignatus	—	—	—	—	—	—	1·13	—	1·20	7·5	—	—	—	—	6·4
Cymindis humeralis	0·56	0·57	0·58	—	—	—	—	—	—	8–11	—	—	16·7	—	—
Arsinoë grandis	—	0·73	—	1·12	—	1·13	—	—	—	13–15	1·5	—	19·2	12·4	—
Lebia scapularis	—	0·30	—	—	—	—	—	—	—	4–5·5	—	—	15·8	—	—

Lebia chlorocephala	—	0·55	—	—	—	—	—	—	—	5–7·5	—	—	11·4	—	—
Onota floridana	—	—	—	—	0·60	—	—	0·90	—	5–6	—	1·5	—	9·2	6·1
Plochionus pallens	—	—	—	0·67	—	0·79	—	1·09	—	7–9·5	—	1·5	—	12·0	8·0
Plochionus timidus	—	—	—	0·71	—	0·77	1·05	—	1·13	7–7·5	—	1·5	—	9·8	6·5
Calleida purpurea	—	—	—	—	0·94	—	—	1·31	—	7·5–9	—	1·4	—	8·8	6·3
Calleida decora	—	—	—	—	0·90	—	—	1·28	—	7–8·5	—	1·4	—	8·6	6·1
Andrewesella 3-vittata	—	—	—	—	—	—	—	0·71	—	5	—	—	—	—	7·0
Dromius agilis	—	—	—	—	—	—	—	0·77	—	6	—	—	—	—	7·8
Dromius 4-maculatus	—	—	—	—	—	—	0·66	0·71	0·75	5–6	—	—	—	—	7·7
Dromius linearis	—	—	—	—	0·52	—	—	—	—	5	—	—	—	9·6	—
Risophilus atricapillus	—	—	—	—	0·51	—	0·65	0·68	0·70	4·5–5·5	—	1·3	—	9·8	7·4
Oecornis nidicola	0·39	0·40	0·42	0·57	0·58	0·60	0·74	0·80	0·83	6–7	1·5	1·4	16·3	11·2	8·1
Colliuris melanura	—	—	—	—	—	—	—	0·90	—	6·5–7·5	—	—	—	—	7·8
Leptotrachelus dorsalis	—	—	—	—	—	—	—	0·84	—	6·8	—	—	—	—	8·1
Drypta dentata	—	—	—	—	—	—	—	1·27	—	7–9	—	—	—	—	6·3
Desera australis	—	—	—	—	0·75	—	—	1·05	—	10·5	—	1·4	—	14·0	10·0
Galerita lecontei	—	—	—	—	—	—	—	2·30	—	17–18·5	—	—	—	—	7·7
Galerita nigra	—	—	—	—	—	—	—	2·62	—	18	—	—	—	—	6·8
Galerita simplex	—	—	—	—	—	—	—	1·92	—	14·5	—	—	—	—	7·6
Mormolyce phyllodes	—	—	—	—	3·45	—	—	—	—	45–60	—	—	—	15·4	—
Eccoptoptera mela	—	1·54	—	—	—	—	—	—	—	17–19·5	—	—	12·0	—	—
Polyhirma hemiraphis	—	1·10	—	—	1·44	—	—	—	—	14·5–18	1·3	—	14·8	11·3	—
Polyhirma ukerewensis	2·0	—	2·3	—	—	—	—	—	—	22–28	—	—	11·6	—	—
Anthia stygne	3·0	—	3·2	—	3·9	—	5·3	—	5·4	35–42	1·3	1·4	12·4	9·9	7·2
Anthia 10-guttata	—	—	—	—	—	—	—	4·5	—	30–36	—	—	—	—	7·3
Anthia crudelis	—	4·1	—	—	—	—	—	—	—	40–50	—	—	11·0	—	—
Anthia 12-guttata	—	—	—	—	3·2	—	—	—	—	35	—	—	—	10·9	—
Anthia 6-guttata	—	—	—	—	4·7	—	—	6·5	—	40–42	—	1·4	—	8·7	6·3
Pheropsophus hispanicus	0·32	—	0·33	—	—	—	—	—	—	16–18	—	—	52·0	—	—
Pheropsophus africanus	0·38	—	0·39	—	—	—	—	—	—	15–18	—	—	43·0	—	—
Brachinus crepitans	—	0·25	—	—	—	—	—	—	—	7–10	—	—	34·0	—	—

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[13] The factors are as follows: *a*, head-width of second stage divided by that of first; *b*, of third by that of second; *c*, *d*, *e*, length of adult divided by head-width of 1st, 2nd and 3rd stages respectively.

[14] In the species of *Carabus* the index-number at the average refers to the number of specimens measured, where more than two larvae of one stage are available.

of the HARPALINAE impilae, which was unknown to me in 1936 (*Ent. Blätt.* **32** : 43).

The close relationship between Licinini, Panagaeini and Chlaeniini, obvious in the larvae, is also conspicuous in the adults. Böving and Craighead have, therefore, united the former two groups into one, but the adults would not bear out this conclusion, and the larvae, in spite of the transitional forms, form quite distinctly two aggregates.

Key to the tribes of CARABIDAE-larvae.

1 (2). Cutting edge of retinaculum strongly denticulate. Tergites extremely broad, broadly overhanging the pleurae, with strongly lobate hind angles (see fig. 72), the 9th pointed at hind angles. Inner lobe of maxillae present as a strong cone, bearing a seta (see fig. 52). Cerci very short, horn-shaped, unarmed, and not articulating at the ninth tergite. Antennae at least twice as long as the mandibles, second joint longer than third or fourth, the last joints pubescent 1. Cychrini.

2 (1). Cutting edge of retinaculum very seldom denticulate, but then the tergites not overhanging the pleurae. Cerci seldom short, horn-shaped, and unarmed, but then either the antennae not much longer than the mandibles, or the tergites narrower and exposing the pleural and often latero-dorsal regions (figs. 69–71), or the inner lobe of maxillae absent (figs. 48, 49).

3 (4). Cerci horn-shaped, short and with one or two (sometimes doubled) teeth or spines (fig. 75), seldom simple and slender,[15] but then they are entirely smooth and bare (fig. 72), and the 9th segment is divided along median line. Antennae usually hardly passing the apex of mandibles, second joint distinctly longer than any of the others, much longer than the fourth, the last joints with only a few setae. Inner lobe of maxillae present as a strong cone, bearing a seta; third joint of the maxillary palpi well developed, usually longer than at least one of the two other joints, never much shorter than one of them. Cerci never articulating at the ninth tergite, though the latter is sometimes divided along median line by a membranous area (fig. 72). Apex of last joint of labial palpi with one or two subcircular sensoria which may be fused into one oblong sensorium . . . 2. Carabini.

4 (3). If the cerci are horn-shaped, *i.e.* heavily chitinised and gradually pointed, and upcurved, they are unarmed; if they are long and slender, they are not entirely bare or the ninth abdominal tergite is entire.

5 (6). Cerci articulating at the ninth tergite (fig. 69), unjointed, leathery, slender (much longer than the tenth segment) and provided with a few nodules, bearing setae (and, in older larvae, sometimes sparse, fine hairs). Nasale with 4–6 strong teeth, or a horn bearing these and often a very small unpaired median one (figs. 3, 4). Mandibles very long, slender and curved, with a well-developed retinaculum. First antennal joint as long as or longer than second

3. Nebriini, Notiophilini.

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[15] The definition of the larvae of Carabini is complicated by the fact that the cerci of *Ceroglossus* (found only in the Andes from Tierra del Fuego to central Chile: Prov. Colchagua) are long, straight and simple and that those of the first stage are said to be jointed and are figured as having single, small setae (Claude-Joseph), and that the cerci of *Calosoma* in the first stage (with egg-bursters traceable at the inner side of the posterior half of the frontal sutures) are often simple (Lapouge). Otherwise the cerci of the Carabini are very distinctive and will enable the larvae to be recognised at once. The first-stage larva of *Ceroglossus* would probably be traced to Licinini or Panagaeini in the present paper, but would fit neither tribe.

6 (5). If the cerci articulate at the ninth segment, they are either jointed (fig. 79), or very short (shorter than the tenth segment), or only beset with numerous fine hairs (fig. 80).[16]

7 (8). Ninth abdominal segment transformed into a large terminal disc with a fringe of short setae (fig. 2). The disc consists of three pairs of sclerites, the ventral of which are more or less deeply divided in tongues. Maxillae (fig. 5) with a long and strong inner lobe, which is not much shorter than the outer lobe. Antennae with the first and third joints long, the second and fourth very short. Abdomen upcurved, with the tergites indistinct. Trochanters and femora very long, tibiae and tarsi very short, not longer than wide, tarsi with two unequal claws (fig. 41) . . . . 4. Ozaenini.

8 (7). Ninth abdominal segment more or less tapering, not transformed into a terminal disc. Tergites usually very distinct.

9(10). Tarsus with a pair of very long and fine, curved empodial hairs (between the base of the claws), which are much longer than the claws. Ligula and inner lobe of maxilla very long, the former almost as long as the labial palpi, and with the setae on sides, basad of middle, the inner lobe not much shorter than the outer lobe and with the seta small and close to base. Mandibles with two strong teeth, subbasal penicillus absent. Nasale forming a short horn. Second antennal joint shorter than the third, the first joint also short. First to fifth tergites with 3 setae in L I and a dense row of setae (particularly on tergites 3–5) in L III along hind margin of either side. Head not constricted at base. Pronotum much wider than any of the other tergites. Cerci fixed, slightly nodose, with setae. The apex of the femora and tibiae with a whorl of strong setae; two equal claws
5. Omophronini (genus *Omophron* Latr.).

10 (9). If empodial hairs are present which are longer than the claws (fig. 36), then the inner lobe of maxilla absent. Ligula short, shorter than the first joint of the labial palpi, the setae at apex of dorsal surface or absent. Mandibles very seldom with two strong teeth.

11(12). Outer lobe of maxillae (fig. 48) very stout, the basal joint more than twice as wide as the first joint of palpi, the second joint produced at apex into a long threadlike process of at least the length of the second joint, the greater part of the latter and the process usually covered by a thick layer of a hyaline exudation, the palpi extremely slender, not very long, terminal joint (as that of labial palpi) divided; inner lobe absent. Ninth tergite divided along median line, the cerci thus movable. Retinaculum of mandible strongly serrate, close to base of mandible, the latter obliquely truncate interiorly. Ligula multisetose. Nasale with a pair of strong spines and some small, pointed teeth. . . . . 6. Loricerini (genus *Loricera* Latr.).

12(11). Outer lobe of maxillae never conspicuously stouter than palpus, the second joint without a threadlike process and without exudation.

13(14). Cerci (figs. 73, 74) long, fixed and with conspicuous setiferous processes (except in first-stage larvae). Clypeus with a short though distinct triangular horn, the margins of which are denticulate. Antennae inserted more outward from base of mandibles, the outer margins of the antennal foramina reaching more laterad than those of the mandibles. Last joint of maxillary palpi much shorter than first and second. Two equal claws. Tergites strongly margined . 7. Elaphrini.

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[16] The first-stage larvae of some Chlaeniini fit the definition of Nebriini and would be identified as *Pelophila*. They differ from the latter larvae by much wider, more or less complete, abdominal tergites, the shorter second joint of the outer lobe, not more strongly projecting paramedian teeth of the nasale, different coloration, etc.

14(13). Cerci (if present) without setiferous processes, but usually with setiferous nodes (figs. 70, 78, 81).

15(16). Ventral and pleural sclerites (fig. 89) complete, filling up the ventral surface of the abdomen, and separated from each other by narrow sutures, the pleural sclerites filling up the whole length of the segments, tergites rather rectangular, broad and almost completely covering dorsum, nota seldom margined laterally. Maxillary stipes without a hairy lobe on inner side of apex. Abdomen strikingly parallel (fig. 76), the tergites 1–8 of practically equal width. Third antennal joint without appendage (figs. 9, 51), if two claws are present. (The tergites of thorax are margined in *Clivina* only, in which the sclerites are, moreover, not quite so complete as in the other genera. The strongly *depressed*, bandshaped cerci, which are excavated on ventro-interior surface—fig. 76—in connection with the parallel abdomen and the single tarsal claw will, however, enable *Clivina* to be recognised) . 8. Scaritini.

16(15). Ventral and pleural sclerites incomplete (figs. 70, 71, 73), more or less broadly separated from each other, seldom as in Scaritini, but then the maxillary stipes extending into a hairy lobe on inner side of apex (fig. 16), or the abdomen tapering in the normal way. Tergites usually exposing spiracles and pleurae more or less broadly, often margined, the pronotum usually margined. (HARPALINAE.)

17(30). Inner lobe of maxillae absent (figs. 46, 49).[17]

18(19). Cerci variable, usually either jointed (figs. 81, 83, 86, 87) or short or coniform (fig. 88) or absent (fig. 1); very seldom of normal length, subcylindrical, leathery, and with some setiferous nodes, but then the tarsi with two claws, and the tergites not margined at sides. Third joint of the maxillary palpi never subdivided into two jointlets (HARPALINAE truncatipennes) . . . . 45.

19(18). Cerci of normal length, slender, more cylindrical and tapering by steps (not gradually tapering = coniform), leathery, and with some setiferous nodes, never jointed (see figs. 70, 71). Tarsi with one or two claws, in the latter case either the tergites margined at sides, or the third joint of the maxillary palpi subdivided (fig. 49) into two jointlets (HARPALINAE piliferae).

20(27). One strong tarsal claw, or two claws (very seldom), but then the second joint of the outer lobe much longer than the first, or the third joint of the maxillary palpi and the second of the labial palpi distinctly subdivided (fig. 49). Tergites not margined laterally (except in *Axonya* of the Broscini, but then the inner lobe present and quite strong).

21(24). Second joint of the outer lobe as long or practically as long as the first joint, usually longer (figs. 46, 49). Nasale usually more or less protruding on the median line (figs. 24–26), seldom broadly truncate. Cerci very evenly rounded interiorly, more or less converging at apex. Cervical keel absent.

22(23). Third joint of the maxillary palpi (fig. 49) subdivided into two, the palpi thus 4-segmented; second joint of the labial palpi usually divided into three (fig. 49). One claw, seldom two . . . . . 9. Trechini.

22(23). Second joint of the labial palpi and third of the maxillary palpi not subdivided (fig. 46). One claw . . . . 10. Bembidiini.

24(21). Second joint of the outer lobe much shorter than the first, never exceeding two-thirds of its length (fig. 6). Nasale broadly produced and truncate or emarginate (fig. 27), never protruding on median line.

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[17] The long, lobiform, haired process at the inner apical end of the stipes in Anthiini (fig. 16) is not regarded as a genuine inner lobe.—One exception (*Axonya*, Broscini) and a few transitions (Ctenodactylini, some *Abacetus*, *Drimostomina*) are referred to under both possibilities.

25(26). First antennal joint shorter than the second and third, the latter two subequal, the appendix of the third joint at two thirds. Second joint of maxillary palpi very small, hardly longer than the third, and less than half as long as the first. Median part of clypeus broadly emarginate, denticulate. Cerci with slight setiferous nodules. A supra-ocular sulcus reaches the middle of the temples, but does not extend to the ventral surface, a ventrolateral sulcus extending from level of ocelli to dorsal surface of neck (but not defined by a cervical keel) is prolonged on ventral surface by a strong groove, which is exteriorly defined by a strong carina, to almost occipital margin. Mandibles with a penicillus near base. Claw without any setae, almost as long as tarsus. (Figs. 6 and 27) . . 11. Pogonini (genus *Pogonus* Curtis).

26(25). First antennal joint longer than second and third. Second joint of the maxillary palpi about twice as long as the third and at least two-thirds as long as the first. Cerci with strong setiferous nodes. Ocelli surrounded by a sulcus posteriorly and dorsally, and a more or less distinct pair of shallow furrows on ventral surface, originating from ventral articulation of mandibles, but no ventro-lateral groove present 12. Broscini.

27(20). Two tarsal claws, the second joint of the outer lobe at most as long as the first, the third joint of the maxillary palpi and the second of the labial palpi not subdivided. Tergites margined laterally (*Caelostomus* ?). No long adhesive hairs at the base of the claws.

28(29). Mandibles without a penicillus. Second antennal joint not shorter than the first and third. Second joint of maxillary palpi distinctly longer and stouter than third. Nasale produced or hardly defined but never broadly produced and defined by a pair of small but distinct teeth, adnasalia distinctly behind level of nasale. Inner lobe absent . . . . 13. Patrobini.

29(28). Mandibles with a penicillus (see figs. 57–59) near base. Second antennal joint distinctly shorter than the first and third. Second joint of maxillary palpi not longer and hardly stouter than the third.[18] Nasale broadly or hardly produced, adnasalia slightly produced, level with the nasale. Inner lobe usually vestigial (fig. 54) Pterostichini : *Drimostomina* etc.

30(17). Inner lobe of maxillae present (figs. 47, 50, 52, 55), almost always with a seta at apex or at side (HARPALINAE impilae).

31(42). Antennae not, or slightly, longer than mandibles (figs. 10–12), hardly ever approaching one-and-one-half times their length, but then either the epicranial suture well developed or the anterior margin of frontal piece not evenly emarginate over its entire width.

32(41). Tergites incomplete, not covering dorso-lateral parts of abdomen (figs. 70, 71). Cerci, if present, always with setiferous nodes.

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[18] Nasale forming a small, pointed, triangular horn. Second joint of maxillary palpi much longer and somewhat stouter than third. Sclerites dark brown. Cerci with a strong node in middle of outer surface : see first-stage larva (with keel-shaped egg-bursters) of *Elaphrus*.—I have a puzzling single larva from Poland : Kielce, *Netolitzky* leg. and ded., which has the head of *Elaphrus*, but simple cerci, though it is a second or third instar (hw. 1·01 mm.). The claws are very long and slender as in most Masoreini, the tergites are indistinctly margined, the first, the lateral quarter of the second to seventh, and the pronotum being pale testaceous, the rest of the dorsum and the cerci dark brown, with numerous secondary hairs. There seems to be a vestigial inner lobe, and the tergites are almost complete. The larva, thus, combines characters of the Masoreini, Chlaeniini and Elaphrini, but the nasale and insertion of the antennae strongly indicate the latter tribe. Of this, however, no member occurs near Kielce which is likely to have simple cerci in later stages.

33(34). Mandibles slender, at least thrice as long as wide at base (see fig. 6). Tergites almost always margined laterally, usually coloured in brown shades. Cervical groove distinct (fig. 23), defined posteriorly by a curved keel, seldom absent, but then the neck not defined from temples and, almost always, antennae five-segmented[19] . . 14. Pterostichini.

34(33). Mandibles more or less stout (figs. 7, 10–12 and 59), less than three times as long as wide at base, usually not more than twice as long as wide, seldom considerably longer, but then the base broad in comparison with the body, the retinaculum near base and only the part between it and apex prolonged and with several teeth (fig. 58). Tergites not margined laterally, usually coloured in yellow shades.

35(38). Claws equal. Maxillary stipes divided near middle by a transverse, membranous zone, the apical part with a longitudinal, comb-like row of strong, inwardly directed setae on dorsum (fig. 10); inner arm of cardo simple and narrow.

36(37). Nasale (fig. 31) with only two very long and widely separated teeth (besides fine denticulation and a minute median tooth at a lower level), adnasalia produced, forming a blunt tooth. Seta of inner lobe apical, though the ventral surface of the lobe is produced beyond its base into a minute spine. Ninth ventrite without a pair of setae in middle of length. Egg-bursters of first stage keel-shaped (fig. 65). Epicranial suture absent . . . . 15. Zabrini (genus *Zabrus* Schellenberg).

37(36). Nasale (fig. 10) with 4–6 subequal, small teeth, which are not more distant from each other than by their own width (denticulate on rest of front margin), adnasalia not or slightly produced. Seta of inner lobe lateral . . . . 16. Amarini.

38(35). Claws unequal or only one claw present. Maxillary stipes not divided, inner arm of cardo usually forming a conspicuous, granulose or spinose knob (figs. 11, 50; if this is not present, the claws are very strongly unequal, or only one claw present).

39(40). Only one claw present, which may, however, be bifid (the two points unequal) or provided with an obtuse-angular dilatation near base. Cerci, ocelli and penicillus of mandible absent. Frontal piece broadly reaching hind margin of head (fig. 7). Head often narrowed and rounded to base, but without a cervical groove and keel. Tibia and tarsus very short and robust, transverse at least on front legs. Tenth abdominal segment very short and stout, sclerites of abdomen weak. Mouth-parts and antennae richly setose. Palpiger much longer than wide, longer than any of the palpal joints. Termitophilous larvae which become increasingly physogastric with age. (First stage unknown) . . . . 17. Orthogoniini.

40(39). Two free claws present. Cerci, ocelli and penicillus of mandible present (figs. 11, 12, 58, 59). Frontal piece not reaching hind margin of head (figs. 11, 12), epicranial suture well developed, though not long. Cervical groove present (except in *Amblystomus*?). Tibia and tarsus longer, usually much longer, than wide . . . . 18. Harpalini.

41(32). Tergites complete, more or less completely covering dorso-lateral parts of abdomen, or, if they are less complete, the cerci filiform and pubescent (fig. 79). Frontal piece often reaching hind margin of head. Neck not defined. Cutting edge of mandibles and retinaculum often minutely serrate, mandibles moderately slender, at least two-and-a-half times as long as wide at base . . . . 19. Chlaeniini.

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[19] Cervical curved keel absent, the neck defined from temples by a broad impression that connects the temples across dorsum, antennae four-segmented :—*a*(*b*) Only one strong claw. Penicillus absent : see *Axonya* (Broscini).—*b*(*a*) Two equal claws. Penicillus present : see first-stage larva of *Blethisa* (Elaphrini), which probably has cerci without processes and would thus have the characters of the Pterostichini, except for the cervical groove.

42(31). Antennae at least twice as long as mandibles, seldom only slightly more than one-and-a-half times as long (fig. 15, *Rembus*), but then the frontal piece reaches occipital foramen and is evenly emarginate over its entire anterior width. Neck not defined. Mandibles serrate between retinaculum and apex (except *Rembus* and *Tefflus*). Epicranial suture absent or short.

43(44). Front margin of frontal piece membranous and microscopically fringed (*Badister* ?, *Dilonchus* ?, antennae not pubescent), nasale never projecting (fig. 15). Antennae with the normal small number of setae, even on the last two joints, seldom the latter joints pubescent (*Dicaelus*). Cerci usually fixed, seldom articulating at ninth tergite, but then the anterior margin of frontal piece shallowly emarginate over its entire width . . . . 20. Licinini.

44(43). Front margin of frontal piece entirely sclerotised and not fringed, nasale distinctly though often very slightly projecting (figs. 20, 21). Antennae pubescent, at least the last two joints (fig. 21). Cerci (figs. 80, 82) usually pubescent or with small setulae, without nodules, almost always articulating at ninth abdominal tergite (if they are fixed, both the nasale and adnasalia produced and dentate—fig. 21—and the second joint of labial palpi strongly axe-shaped) . . 21. Panagaeini.

45(58). Cerci more or less long and slender, much narrower than tenth abdominal segment (figs. 81, 83, 86, 87), seldom very short or absent, but then the claws with a distinct (though sometimes minute) tooth more or less near middle of ventral surface.

46(57). Two claws. The retinaculum slender, small or absent, more or less near middle or even basad of middle (figs. 13, 14, 19, 22, 34, 57). Ligula small, long and narrow, or absent, the apical setae closely placed or wanting (figs. 13, 14, 19, 22.)

47(56). Neck more or less broad, more than half as wide as head (figs. 13, 14, 19, 22). Cerci with usually 6–11 joints, seldom with more joints (fig. 86), but then the anal tubes with chitinous crotchets. Claws sometimes toothed, or tarsus with an unpaired (but often bilobed) pulvillus (fig. 45), but the individual claws never each with an appendix at base. If the clypeus is horned, the horn is very much shorter than the frontal piece.

48(55). Cutting edge of mandibles smooth between retinaculum and apex, seldom very minutely serrulate, but then the head without a differentiated neck-part.

49(54). First antennal joint as long as or longer than third (fig. 22). Head without a cervical groove or keel before base. Frons not reaching hind margin of head, epicranial suture present. Claws simple, pulvillus absent. Tenth abdominal segment without protrusible anal tubes and unarmed.[20] Tergites testaceous or even paler.

50(53). Claws subequal, strikingly (except in *Masoreus*) slender and long [20] (fig. 35). Penicillus of mandible present, retinaculum distinct, but only small or moderate. Head-capsule wider than long, neck not constricted. Third antennal joint without a dorsal and a ventral sensorial area, but with an appendage at outer part of apex. Six well-developed ocelli.

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[20] From the slide at hand, it cannot be ascertained whether the tergites are margined or not in *Caelostomus*. If they are not margined, this genus would be traced to this paragraph, but it has normal claws and distinct anal tubes which are covered by numerous small crotchets, the cerci show no trace of a segmentation.—The first-stage larva of *Elaphrus* might also be run down to this paragraph, as the tergites are not distinctly margined. The claws are of normal length, the nasale forms a simple, small, triangular horn, the egg-bursters are keel-shaped, the cerci not jointed, but with a conspicuous node at middle of outer surface; sclerites dark brown.—See p. 17 (note 18).

51(52). Basal joint of the outer lobe simple, apical joint subtruncate, the two joints subequal. Adnasalia obtuse, nasale forming a short and more or less broadly truncate or emarginate prominence . 22. Masoreini.

52(51). Basal joint of the outer lobe with a conspicuous process at outer side of apex (fig. 53), apical joint pointed, much shorter than the basal joint. The last two joints of the maxillary palpi longer than wide, but small, shorter together than the first joint. Adnasalia strongly projecting and pointed towards sides, nasale forming a rather long subtriangular prominence with bifid apex. Cerci very slightly longer than mandibles, soft, not distinctly jointed (*ex* Gardner) 23. *Tetragonoderini (genus *Tetragonoderus* Dejean).

53(50). Claws very unequal, slender. Penicillus of mandible absent, base of cutting edge of mandible obliquely truncate, the mandible thus narrowed to base, retinaculum almost absent, indicated only by a slight angular dilatation of the cutting edge at the anterior end of the truncature (fig. 22). Head-capsule longer than wide, neck strongly constricted, not much more than half as wide as head. Third antennal joint with large, oblong dorsal and ventral sensorium, which are more than half as long as the joint, but without apical appendage (fig. 22, *sn*). Terminal joints of palpi and especially outer lobe long and pointed. Tarsi long, with six longitudinal rows of short hairs. Cerci 11-segmented (fig. 83). Adnasalia produced, rounded exteriorly and pointed inward at apex, nasale with two rather strong teeth, two small teeth between each adnasale (fig. 22, *ad*) and paramedian tooth . . . . 24. Zuphiini ?

54(49). First antennal joint shorter, usually very much shorter than third joint (figs. 13, 14), very seldom the first joint subequal or longer, but then the head with a cervical groove and carina before base (fig. 19), or the frons reaching hind margin of head. Claws of normal length, or small, often toothed or a pulvillus present below the base of the claws. Tenth abdominal segment usually with a pair of protrusible anal tubes which bear each a row of hooks (figs. 81, 86, 88) . 25. Lebiini.

55(48). Cutting edge of mandibles serrate between retinaculum and apex. Head with a distinct though rather broad neck, which is either considerably narrower than the head or defined anteriorly by a cervical groove and keel. Cerci slender and long, with 4–5 joints, including the fixed basal part. Two equal, simple claws . . . . . . 26. Colliurini.

56(47). Neck strongly constricted, much less than half as wide as head. Cerci very long, with more than ten joints (seldom few very long joints, but then the horn of the clypeus not shorter than the entire frontal piece, bifurcate), ninth abdominal segment divided along median line. Claws with an appendix at inner or ventral side of base (figs. 37, 42, 43). Nasale forming a short or long horn. Third antennal segment not dilated to apex, appendix small, inserted at apex. Anal tubes indistinct, unarmed . . . . 27. Dryptini.

57(46). One claw, which is not toothed though somewhat obtusely dilated at base, where a minute setula arises. Mandibles with a very strong retinaculum close to apex and directed forward and inward, so that the apex almost appears to be bifid, penicillus present (fig. 18). Ligula rather broad, with an additional pair of setae on sides, the apical pair more remote from each other than usually. Cerci horn-shaped, though rather slender, with a few setae and some small hairs. Appendix of third antennal joint minute, the joint hardly dilatate in apical half (fig. 18). Apical joints of outer lobe and maxillary and labial palpi small. Epicranial suture long. Sclerites (except those of head, prothorax and part of ninth tergite) pale, with a few setae and rather numerous short setulae 28. Mormolycini (genus *Mormolyce* Hagenbach).

58(45). Cerci absent, very short (much shorter than tenth abdominal segment) or very stout (at least as stout as tenth segment: figs. 84, 85). Claws not toothed (a dilatation of the base is not regarded as a tooth, but only a separate dilatation some way from it).

59(62). Cerci very large and stout (figs. 84, 85). Ninth tergite divided along median line. Tooth of mandibles normal (figs. 16, 17). Maxillary palpi stout. Ligula very distinct, chitinous, the two setae inserted on dorsal surface, not at apex. As far as known, the body is always parallel-sided, very hairy, some segments are almost always reddish or yellow, the remaining segments pitchy-brown to black.

60(61). Maxillary stipes not produced at inner end, but first joint of outer lobe fused with stipes and hairy (fig. 17). Antennae 4-jointed, second and third joints separated by a suture. Tarsi with two claws. Cerci more or less blunt with a hyaline pointed rudiment of a second joint (fig. 85) . . . . 29. Helluonini.

61(60). Maxillary stipes produced at inner end into a long, lobiform, hairy process, first joint of outer lobe articulating at stipes (fig. 16). Antennae 3-jointed. Tarsi with 2 unequal claws, one of them often very small and indistinct. Cerci produced into a point at apex which is of the same colour as the cerci (fig. 84) . . . . 30. Anthiini.

62(59). Cerci short or missing, not movable. Ninth tergite entire. Tooth of mandibles small (fig. 8) or missing. Maxillary palpi normal (at least in young larvae). Ligula small or missing, without setae. Third antennal joint (fig. 8) inflated (in young larvae). No striking coloration. Tarsi with 1–2 claws, in the latter case the mandibles without retinaculum and cerci absent.[21] Maxillary stipes not transversely divided in apical half. . . . . 31. Brachinini.

Keys to the Genera.

1. Cychrini.

Frontal piece reaching the hind margin of head. Nasale simply rounded, without any teeth. Antennae twice as long as mandibles or longer, rather densely setose or pubescent on last three joints; second joint distinctly longer than the others. Cutting edge of mandible smooth, of retinaculum strongly denticulate. Maxillae: inner lobe a blunt chitinous cone with a seta; palpus with the first joint much shorter than the other two; third joint well developed. Labial palpi with the apical joint more or less axe-shaped, with one long, band-shaped sensorium at apex. Legs with two strong equal claws. Nota and tergites extremely broad, broadly overhanging the pleurae, with strongly lobate hind angles at least on the posterior segments, ninth tergite pointed at hind angles. Cerci very short, horn-shaped, unarmed, not articulating at the ninth tergite, their apices separated by less or little more than the width of the tenth segment.

1 (4). Cerci well separated from ninth tergite, as long on outer as on inner side, not flattened, passing level of hind angles of ninth tergite. Ligula absent or very broadly rounded, joints of outer lobe of maxilla subequal. Ventral sclerites not fused on first to seventh abdominal segments.

2 (3). Last joint of labial palpi subcylindrical from middle to apex. Second antennal joint only slightly longer than third, first distinctly longer than fourth. Hind angles of tergites rounded, their lobes rounded,

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[21] Two claws. Mandibles with retinaculum. Cerci present, very short and broad, hump-like. Maxillary stipes transversely divided in apical half: see ?Broscini, genus *Cnemacanthus.*

distinct only from 6th abdominal segment onwards (very slight on fourth and fifth). Nasale very distinctly prominent, half as wide as each adnasale and more prominent. Ventral sclerites with rather numerous setae, secondary setae not much shorter than primary ones, hypopleurites and epipleurites both with several conspicuous setae. Cerci shorter and stouter . . . . *Cychrus* Fabricius.

3 (2). Last joint of labial palpi subtriangular in side-view, obliquely truncate at apex. Second antennal joint much longer than third, first distinctly shorter than fourth. Hind angles of tergites acute, though the apices narrowly rounded, all of them lobate, though not very broadly. Nasale very slightly and broadly rounded, at least as wide as but less prominent than each adnasale. Ventral sclerites with few and very small secondary setae, the hypopleurites without outstanding setae, the epipleurites with one only. Cerci longer and more slender . . . . *Scaphinotus* Dejean.

4 (1). Cerci partly fused with ninth tergite, twice as long at inner as on outer side, very short and flattened, not passing level of hind angles of ninth segment. Ligula well developed. Second joint of outer lobe of maxillae much shorter than first. Ventral sclerites fused on third to seventh abdominal segments. Second joint of labial palpi subtriangular . . . . *Sphaeroderus* Dejean ?

2. Carabini.

Frontal piece not reaching hind margin of head, epicranial suture thus distinct. Nasale toothed. Antennae seldom much longer than mandibles, with few, 3–5, setae even on the last joints, almost all of them forming an apical whorl, second joint distinctly longer than the others. Cutting edge of mandible simple, of retinaculum simple or with an auxiliary tooth. Maxillae: inner lobe a blunt chitinous cone with a seta; palpus with the third joint well developed, usually longer than the others. Labial palpi with the apical joint oval to cylindrical to clavate, the apex with one or two, sometimes fused, subcircular sensoria. Legs with two strong equal claws.

1 (2). Tarsi with some spinose setulae on dorsal surface, arranged in two longitudinal rows on anterior pairs. Cerci very long, straight, without setae, and simple (fig. 72). Ninth abdominal segment membranous along median line, so that the cerci are movable.[22] The basal two joints of the maxillary palpi much longer than wide. Retinaculum with a strong auxiliary tooth on cutting edge. Head with a semicircular blunt keel from one antenna to the other and passing through the posterior part of the frontal piece. Nasale with two, sometimes bifid, teeth which are separated from each other by a rather broad and deep emargination. Tergites rather broad, not narrower than the mesonotum, the epipleurites, however, protuberant at sides, all the tergites with lobate hind angles (fig. 72). *Ceroglossus* Solier.

2 (1). Tarsi usually entirely bare on dorsal surface (except for the usual two apical spinose setulae above the claws), seldom with a few setulae, but then the basal two joints of the maxillary palpi not longer than wide. Cerci more or less curved and horn-shaped, always with spines or teeth (fig. 75) except in first-stage larvae of *Calosoma*.

3 (4). Epipleurites divided into a large anterior and a small posterior part (fig. 75). The basal two joints of the maxillary palpi not longer than wide. Median incision of clypeus at least as deep and wide as the one dividing the two teeth of either side (fig. 29), or the latter fused. Tergites very seldom broad, almost always without lobate hind angles on most of the segments (fig. 75) . . *Calosoma* Weber.[23]

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[22] In quite a different way, however, from that of Nebriini.

4 (3). Epipleurites not entirely divided though notched on dorsal and ventral margins before apex. The basal two joints of the maxillary palpi usually longer than wide. Median incision of clypeus often narrow or even absent . . . . *Carabus* L.[23]

3. Nebriini, Notiophilini.

Frontal piece not reaching the hind margin of the head (*Pelophila*?). Nasale produced into a short or long horn with four to six strong teeth, and often a very small median, more ventral tooth (hypodon), or without a distinct horn but with four distinct teeth. Antennae not longer than the mandibles, with few setae on the last joints, though the first joint may be more hairy, the second joint always shorter than the first, never longer than the third and often much shorter than it. Mandibles long and sickle-shaped, the cutting-edge and the retinaculum simple, basal penicillus absent. Maxillae with or without an inner lobe. Cerci articulating at hind margin of ninth tergite, leathery, slightly nodose and with setae.—The larvae of the Nebriini and Notiophilini are so closely allied that they are treated together. The only characters which would separate the two tribes are afforded by the tooth of the adnasalia in Notiophilini, and the frontal sutures which are strongly bisinuate and more or less subparallel behind level of ocelli in the Nebriini (fig. 3), whereas they are almost straight and diverging throughout in Notiophilini (fig. 4).

1 (2). No distinct neck present. Tarsi slightly shorter than tibiae. Claws equal. Terminal joints of the maxillary and labial palpi slightly shorter than the first, that of the outer lobe slightly longer[24] than the first. Inner lobe present. Clypeus with four teeth, of which the paramedian ones are more prominent[24] than the more lateral ones (*ex* Johnston and Carpenter) . . . . **Pelophila* Dejean.

2 (1). A very distinct and rather narrow neck present (figs. 3, 4). Tarsi distinctly and often considerably longer than tibiae, claws unequal. Terminal joint of maxillary palpi and of outer lobe much longer than the first joint, of labial palpi usually (except in *Eurynebria*) longer than the first joint.

3 (10). Maxillae with a distinct spiniform inner lobe. Horn of clypeus short or the clypeus simply with four teeth. Apical joint of the labial palpi not more than twice as long as the first joint. Frontal sutures strongly bisinuate and subparallel or slightly diverging behind level of ocelli.

4 (5). Clypeus evenly rounded, the nasale hardly narrower than either adnasale, with four short teeth, the paramedian ones somewhat stronger than the outer ones, the adnasalia hardly defined from nasale by a slight sinuation. First antennal joint rather hairy. Frontal sutures not very distinct, somewhat diverging in the subparallel part. Second joint of labial palpi slightly shorter than the first joint. Terminal joint of the maxillary palpi fusiform, almost subclavate, terminal joint of outer lobe and maxillary lobe cylindrical, bluntly pointed at apex. Colour pale yellowish, dorsum pubescent and alutaceous . . . . *Eurynebria* Ganglbauer.

5 (4). Nasale narrow, much narrower than either adnasale from incision to base of antennae, forming a distinct short horn, bearing four more

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[23] The differentiation of larvae of *Calosoma* and *Carabus* s.l. seems still uncertain in some cases. The groups like *Procerus*, *Callisthenes* etc. are regarded as subgenera by me. It is hardly necessary to include a key to them in this paper, as Lapouge's key in 1929, *Gen. Ins.* **192** : 44–59 will enable them to be distinguished.

[24] Second joint of outer lobe shorter than first. Paramedian teeth of clypeus not more prominent: see p. 15, par. 6.

or less spine-shaped teeth (and a small hypodon), the paramedian ones longer than the outer ones, the adnasalia separated by a distinct though rounded incision. Frontal sutures more distinct, subparallel behind eyes. Second joint of labial palpi slightly to much longer than first. Terminal joint of maxillary and labial palpi and outer lobe conically pointed from middle. Colour more or less brown. *Nebria* Latreille 6 (next couplet).

6 (9). Paramedian anterior setae of abdominal tergites before middle (prae- and post-tergum not considered). Pronotum moderately narrowed to apex.

7 (8). Seta of adnasalia rather distant from angle, the front margin more conspicuously or only emarginate to its outer side, emarginations sometimes indistinct; in first stage the adnasalia and angles often evenly rounded with a small tubercle bearing the seta subgenera *Paranebria* Jeannel and *Nebria* s.str.

8 (7). Seta of adnasalia at angle, which projects more or less, the front margin conspicuously emarginate to the inner side of the seta subgenus *Oreonebria* K. Daniel.

9 (6). Paramedian anterior setae of tergites behind middle. Pronotum strongly narrowed anteriorly with rather straight sides, therefore trapezoidal. Seta of adnasalia at angle, which projects more or less, the front margin conspicuously emarginate to the inner side of the seta . . . . subgenus *Nebriola* K. Daniel.

10 (3). Maxillae without an inner lobe. Horn of clypeus long (figs. 3, 4). Apical joint of all the palpi (including outer lobe) very long and pointed, three to four times as long as the first joint. Frontal sutures distinct.

11(12). Horn of nasale very long, with six spines, not separated from adnasalia, the latter without teeth (fig. 3). Frontal sutures strongly bisinuate, subparallel for a considerable distance behind level of ocelli. Apical joint of labial palpi about thrice as long as the first . *Leïstus* Frölich.

12(11). Horn of nasale of moderate length, with four spines, separated from adnasalia by a strong incision, the outer margin of which forms a spiniform tooth on the interior end of the adnasale (fig. 4). Frontal sutures slightly sinuate, almost straight, and strongly diverging throughout. Apical joint of labial palpi about four times as long as the basal joint . . . . *Notiophilus* Duméril.

4. Ozaenini.

Head strongly narrowed at base though without a distinct neck-part. Frontal piece not reaching hind margin of head, epicranial suture distinct. Nasale forming a blunt prominence, above which the frons is transversely keeled. (This keel is perhaps the original anterior margin of the frons, and the blunt prominence the labrum, the clypeus forming the sloping part. *Physea* suggests this interpretation much less than *Pachyteles*?, and the latter may thus, in this respect, be the most primitive Carabid yet known.) Antennae not longer than mandibles, with few setae; first and third joints long, second and fourth very short. Cutting edge of mandibles simple or slightly dilated beyond retinaculum, the latter simple, strong, basal penicillus absent. Maxillae: inner lobe a long, pointed, slightly curved blade, with a seta on its base; outer lobe almost reaching or passing tip of palpus; joints of the latter short, the palpiger somewhat longer than any one of them. Legs with the coxae, trochanters and femora long and the tibiae and tarsi very short, claws unequal, the posterior one shorter and more outwardly (dorsally) directed. Nota distinct though not very conspicuous, tergites indistinct. Ventral and pleural sclerites of abdomen distinct, the ventral ones small.

Ninth abdominal segment transformed into a curious concave, terminal disc, composed of three pairs of sclerites, the ventral one of which is more or less deeply divided into short or long tongues. Tenth abdominal segment in a ventral emargination of the latter sclerites and more or less enclosed by them.

(The terminal disc, the trend to shortening the apical part of the legs, the proportions of the antennal joints and the general shape of body and head are common to Ozaenini and PAUSSIDAE, which are certainly very closely related to each other. In the PAUSSIDAE, however, the frons reaches the occipital foramen, the mandible bears a prostheca, the palpiger is absent, the outer lobe of maxilla one-jointed, the inner lobe absent, several of the terminal joints of the legs (probably femur, tibia, tarsus and claws) are reduced to a simple claw-shaped appendix of the trochanter (or trochanter + femur), and the ventral plates of the terminal disc are simple.)

1 (2). Labium normal, with subparallel sides. Second joint of outer lobe more slender than basal joint, tapering to apex. Retinaculum directed inward and forward. Transverse keel of frontal piece forming its front margin, under which the median part protrudes, suggestive of a true labrum. One distinct ocellus. Cerci absent. Plates of the terminal disc very large, much exceeding the width of the eighth segment. Dorsal plates perfectly straight on inner side, touching each other in basal third, free though adjacent in the other two-thirds; lateral plates strongly transverse, pointed and not very broadly separated interiorly, widened in the two outer thirds, which are free; ventral plates touching each other on median line above anus, separated ventrally by the small tenth segment, deeply cleft into three long tongues, the most ventral one of which is simple, whereas the two others are bifurcate, thus forming five thin branches in all on either side. The most ventral branches of the two plates are broadly separated (by about the basal width of one dorsal plate). There are no spines or teeth on the terminal disc but a strong tubercle at the base of the dorsal fork of the ventral plate. Larva more slender . . . . *Pachyteles* Perty ?

2 (1). Labium very long and prominent, narrowed from base to apex (fig. 5). Second joint of outer lobe as stout as basal joint, slightly thickened to apex, the apex broad and blunt. Retinaculum directed inward and slightly backward, the cutting edge of mandible slightly dilated distad of retinaculum. Transverse keel of frontal piece much behind the front margin of the latter, the median prominence thus appearing to be part of the frons, not reminiscent of a labrum. No ocelli. Cerci present as a pair of semiglobular granulose humps on the terminal disc. Plates of the terminal disc of moderate size, not much exceeding the width of the eighth segment (fig. 2), without any free inner margins. Dorsal plates straight on dorsal and ventral part of inner side, with a deep excision on middle half, in which the cerci are inserted; lateral plates longer than wide, ventral plates embracing the tenth segment, the most ventral processes almost adjacent, all five processes short and similar, the ventral plates with three tooth-shaped elevations each, one on the most dorsal process, one on the base of the second, and one on the fourth process. Larva larger and stouter, up to 19 mm. long and 4·7 mm. wide *Physea* Brullé.

7. Elaphrini.

Frontal piece not reaching hind margin of head. Nasale produced into a short triangular horn, the margins of which are denticulate. Antennae not longer than the mandibles, the first joint slightly longer than the others, with few setae, inserted outward of and above mandibles. Cutting edge and retinaculum of mandible simple, sub-basal penicillus present. Maxillae: First and second joints of maxillary palpi subequal, third much shorter and thinner. Second joint of outer lobe more or less distinctly shorter than the first. The two joints of the labial palpi subequal, the second coni-fusiform. Two equal claws. Tergites distinctly margined at sides, very hairy. Cerci fixed, leathery, with strong setiferous processes.

1 (2). Cerci with a few fairly long processes, shaped like antlers (fig. 73). Inner lobe absent. Abdominal epipleurites entire. Head testaceous laterally. Tergites with metallic reflections . . . *Elaphrus* Fabricius.

2 (1). Cerci closely beset with very numerous small but prominent setiferous tubercles, appearing spinose-hirsute (fig. 74). Inner lobe present. Epipleurites of first to seventh abdominal segments divided by a vertical pale band into an anterior and posterior half. Head and tergites brown, without metallic reflections . . . *Blethisa* Samouelle.

8. Scaritini.

Head-capsule rectangular, with subparallel sides, usually longer than wide. Frontal piece not reaching hind margin of head, epicranial suture distinct, usually long. Antennae not longer than mandibles, the first joint shorter than either the second or third. Mandibles long and rather slender. Maxillae with the stipes very long, the last joint of the palpi much shorter than the first and second, which are usually rather long. Tergites rectangular and almost completely covering the dorsum, the eighth not appreciably narrower than the anterior ones, the spiracles almost touching the tergites and epipleurites; nota not margined laterally; pleural and ventral sclerites of abdomen complete, the latter separated from each other by only narrow sutures. Cerci fixed, simple, more or less leathery, sometimes jointed.

1(16). Two equal or unequal claws present. Apex of third antennal joint without an appendage, but broadly truncate exteriorly, the truncature membranous with one large or several or many small flat sensoria and, at basal end, a seta (figs. 9, 51). Larvae of large size, seldom under 10 mm. in length, even in first stage. Femora and tibiae (and often even trochanters) with very strong seriate spines. Second antennal joint at least as long as and usually longer than first and never considerably shorter than third joint, usually longer. The first and second joints of maxillary palpi more or less subequal in length, rather long, the third very small, never much longer than the second is wide (fig. 9).

2 (5). Tergites strongly margined. Cerci strongly converging and rounded to apex, not tapering, and without distinct nodes. Nasale transversely trapezoidal, truncate in front, with the angles rounded. Mandibles slightly curved, cutting edge simple and bare, retinaculum small, simple. Maxillae with the inner lobe small, the third joint of the palpi very small, scarcely half as long as the second joint is wide.

3 (4). Second joint of antennae longer than third. Ligula absent, second joint of labial palpi subcylindrical, slightly widening towards apex, with the apex rounded. Ventrite with a single pair of small setae, inner postventrite and hypopleurite without, outer postventrite with one seta . . . . *Pasimachus* Bonelli.

4 (3). Second joint of antennae slightly shorter than third, second joint of labial palpi gradually tapering in apical half, the apex narrowly rounded. Ventrite, postventrites and hypopleurite each with a strong seta and some small ones . . . . gen. indet. Uganda.

5 (2). Tergites not margined. Cerci not or slightly converging, but seldom rounded to apex.

6 (9). Inner lobe strong, pointed, as long as the basal joint of the outer lobe, with the seta on middle of dorso-interior margin. Mandibles rather strongly curved, with the retinaculum extraordinarily large, blade-shaped, broader than the apex of mandible. A strong brush of setae in place of the ligula. Ventrites without setae, outer postventrites with one seta (fig. 89).

7 (8). Cutting edge distad of retinaculum with a loose fringe of short setulae. Nasale produced into a short, subtriangular horn, the apex of which is slightly prolonged and narrower than the antennae. Second and third antennal joints subequal. Inner postventrite without a seta (at least in first-stage larva). Ninth tergite divided along median line, cerci subcylindrical, almost straight, though slightly upcurved at apex, with a few weak nodules in apical half *Storthodontus* Chaudoir.

8 (7). Cutting edge of mandible and of retinaculum finely serrate. Nasale produced into a short horn with subparallel sides which is much wider than the antennae, its apex obliquely truncate on either side, and a small lateral tooth projecting sideways at a lower level than the truncature. Second antennal joint slightly longer than the third. Inner postventrites with a seta (at least in older larvae). Ninth tergite not divided, cerci with two very strong nodes, at which their three sections articulate . . . . . *Dyscherus* Chaudoir?

9 (6). Inner lobe very small or absent. Mandibles long and slightly curved, retinaculum short (fig. 9). Inner postventrites with setae. Cerci strongly nodose, not of equal width throughout. Stipes maxillaris and usually second joint of antennae very long *Scarites* Fabricius 10 (next couplet).

10(15). Tergites pale yellow, each with four pairs of setae along hind margin (besides the setae of the hind angles), ventral arm of ocellar sulcus obsolete. Ventral sclerites each with more than two setae. Dorsal surface of head with a pair of almost straight and parallel longitudinal furrows, bordered exteriorly by a keel, which reach from the inner base of antennae towards the transverse neck-sulcus (fig. 9). Ocelli more or less vestigial or absent, especially those of the second row.

11(14). Posterior half of head not margined at sides, but with a dorso-lateral keel. Second antennal joint and sides of the last abdominal segments not abnormally setose. Third antennal joint with one large, flat sensorium (as in fig. 9).

12(13). Second antennal joint not or hardly longer than first. Mentum triangularly excised at apex, ligula absent. Nasale very broadly and shortly produced and broadly and rather strongly emarginate all over its width. Epipleurites not divided. One large anterior and one small posterior ocellus. . . . subgenus *Distichus* Motschulsky?

13(12). Second antennal joint much longer than first. Mentum not excised at apex, ligula distinct. Nasale transverse, trapezoidal, truncate in front, with the angles slightly receding and obtuse. Epipleurites divided into two parts. Ocelli almost absent, the front row just visible . . . . subgenus *Scaritodes* Putzeys.

14(11). Posterior half of head with a marginal keel at sides, which is an extension along the lateral surface of the transverse basal keel, towards a spot ventrad of the ocelli. Third antennal joint with numerous sensoria on the membranous sensorial area (see fig. 51), second joint longer than any of the others, with a row of long, erect setae on outer surface. Lateral surface of ninth and tenth abdominal segments each with a tuft of dense setae. Nasale subtriangular. Tarsi almost hidden in the terminal fringe of spines on the tibiae subgenus *Scarites* pars a.

15(10). Tergites more or less brown, each with two pairs of setae along hind margin (besides setae of hind angles). Ventral arm of ocellar sulcus usually well developed. Ventral sclerites usually with only single setae (1–2 on each sclerite—1–2 pairs on ventrite—of 1st to 7th abdominal segments). Third antennal joint with several to numerous sensoria (fig. 51) . . . . subgenus *Scarites* pars b.

16 (1). One single strong claw. Appendage of third antennal joint present. Larvae small, seldom reaching 10 mm. in length. Tibiae with a not very dense whorl of spinules at apex, femora without or with two ventral rows of spinules, trochanters without ventral rows. Second antennal joint much shorter than third, shorter than first. First joint of maxillary palpi much longer than second, third much longer than the second is wide. Cerci not nodose.

17(18). Cerci of moderate length, as long as or longer than two tergites, strongly depressed, band-shaped, densely and finely hairy and with a few very fine setae (fig. 76). Terminal joints of all the palpi (incl. outer lobe) much smaller than the preceding joint. Nasale with a rather broad median emargination and two short and broad irregular paramedian lobes. Retinaculum very short and small, not much pointed, less than half as long as the mandible is wide at its insertion. Inner lobe present, with the seta rudimentary . . . *Clivina* Latreille.

18(17). Cerci very short, less than half as long as the ninth tergite, subconical, with a few strong setae. Terminal joint of all the palpi (incl. outer lobe) slightly smaller than the preceding joint. Nasale short and broad, subtriangular, with denticulate margin. Retinaculum slender and curved, of normal length, about as long as the mandible is wide at its insertion. Inner lobe absent . . . . . *Dyschirius* Bonelli.

9. Trechini.

Frontal piece not reaching hind margin of head, epicranial suture well developed. Cervical groove and keel absent. Nasale more or less produced in middle, almost always denticulate. Antennae not longer than the mandibles, with few setae. Mandibles rather slender, with a simple retinaculum and a penicillus. Maxillae: inner lobe absent, outer lobe with the second joint as long as the first or longer, usually much longer, palpi with the third joint subdivided into two (fig. 49). Ligula small, bisetose, second joint of the labial palpi usually subdivided into three. Legs with one strong claw, seldom with two. Abdominal sclerites incomplete, tergites not margined, pubescent between the setae, except in first stage. Cerci rigid, leathery, slender, with weak setiferous nodules on outer and dorsal surfaces, evenly rounded interiorly, more or less converging at apex.

1 (2). Tarsi with two equal claws and a pair of long, fine, band-shaped setae, inserted at their base and extending beyond their apex (fig. 36). Mandibles inconspicuously, bluntly denticulate on cutting edge distad of retinaculum. Apical joint of the labial palpi simple (Perileptina) *Perileptus* Schaum ?

2 (1). Tarsi with one or seldom two claws, without a pair of long setae at the base of the claws. Mandibles simple distad of retinaculum.

3 (8). Nasale evenly and broadly rounded, very slightly projecting, front margin crenulate to bluntly denticulate. Third joint of antennae much longer than second, 1½ times to twice as long. One claw (*Temnostega* ?).

4 (7). Terminal joint of labial palpi once divided [25] or not divided but with a slight break in the outline, thus with a suggestion of a single division, defining two parts, these palpi therefore 2–3-jointed. Ocelli absent. (Aepina.)

5 (6). Head longer than wide. Terminal joint of outer lobe much longer than first joint. Second joint of labial palpi not divided but only with a slight break in the outline. Dorsal surface rather densely and conspicuously hairy.—Larvae in the tidal zone of the European coasts . . . . *Aëpopsis* Jeannel.

6 (5). Head wider than long. Terminal joint of outer lobe not longer (shorter ?) than first joint. Second joint of labial palpi divided. (After Enderlein's figures).—Crozet Islands. . **Temnostega* Enderlein.

7 (4). Terminal joint of labial palpi twice divided, thus forming three subsegments, the palpi therefore four-jointed (fig. 49). Ocelli distinct. Nasale with the denticles much weaker and obliterated in middle. Tergites not hairy, except for the usual setae (1st-stage larva !). (*ex* Jeannel) (Homaloderina) . . . . . . **Iberotrechus* Jeannel.

8 (3). Nasale more or less protruding in middle, usually a median lobe and a pair of lateral lobes or angles distinct, seldom broadly rounded as under 3 (*Typhlotrechus*), but then the second antennal joint as long as the third, and the subdivisions of the second labial joint very conspicuous.

9(10). Two slightly unequal claws. Nasale trilobed, the lateral lobes practically as long as the median one though narrower, front margin of all three lobes irregularly denticulate. (Trechodina) **Amblystogenium* Enderlein.

10 (9). One claw. Nasale with the median lobe alone projecting or more so or with very short and small lobes or not lobed at all. (*Trechina.*)

11(12). Nasale not denticulate, with the median lobe very narrow, very strongly projecting and truncate at apex. Mandibles strongly curved, with the retinaculum very long and slender, slightly longer at its distal margin than the diameter of the mandible distad of the retinaculum. Third antennal joint with the appendix just proximad of middle, very strongly bent inward at this point **Allegrettia* Jeannel.

12(11). Nasale more or less denticulate, with the median lobe subtriangular or indistinct or absent. Mandibles less strongly curved, the retinaculum moderate, always shorter at its distal margin than the diameter of the mandible distad of the retinaculum.

13(14). Nasale almost evenly rounded, rather strongly denticulate, lateral lobes not, or not distinctly defined. Second antennal joint as long as third, much longer than first . . . . . *Typhlotrechus* J. Müller.

15(14). Nasale with the median lobe more or less projecting or acute, or the lateral lobes distinctly defined as a point where the front margin of the head suddenly recedes. Second antennal joint always considerably shorter than third.

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[25] Enderlein describes and figures the labial palpi of *Temnostega* as three-jointed. If this should be incorrect and they were actually four-jointed, this genus could be distinguished from *Iberotrechus* by the lack of ocelli.

16(17). Mandibles short, not longer than the antennae, maxillae very long and slender, the stipes slightly passing apex of mandibles, first joint of labial palpi almost reaching apex of mandibles. No ocelli. Cerci as long as the tenth abdominal segment. Second joint of antennae half as long as third . . . . **Neaphaenops* Jeannel.

17(16). Mandibles long, somewhat longer than antennae; maxillae and labial palpi of moderate length, neither the stipes nor the first joint of the labial palpi reaching the apex of the mandible.

18(19). Nasale triangularly produced, denticulate, the lateral lobes not defined. Legs and setae very long. Cerci as long as the tenth abdominal segment . . . . **Paraphaenops* Jeannel.

19(18). Nasale less produced, lateral lobes more or less defined.

20(21). Median lobe of nasale very small, not or not much projecting beyond lateral lobes. Ocelli absent. No neck-constriction. Cerci and 10th abdominal segment of almost equal length . . **Anophthalmus* Sturm.

21(20). Median lobe of nasale more projecting beyond lateral lobes.

22(23). Nasale tuberculate on dorsal surface of apex . **Trechopsis* Peyerimhoff.

23(22). Nasale denticulate only at border.

24(27). Nasale more produced, subtriangular, with the lateral lobes slightly emphasised and the front margin coarsely denticulate, especially towards sides. No ocelli. Retinaculum very convex distad, more or less humped.

25(26). Neck slightly constricted. The three setulae on vertex on either side of the epicranial suture arranged in an angle of about 150° **Neotrechus* J. Müller.

26(25). Neck not constricted. The three setulae on vertex on either side of the epicranial suture arranged in an angle of about 120° (fig. 49) *Speotrechus* Jeannel.

27(24). Nasale less produced, more trapezoidal, with the lateral lobes usually more strongly emphasised and the front margin finely denticulate.

28(29). Nasale with the lateral lobes forming an acute angle (though with rounded apex), the base of the strong concavity between the median and lateral lobes level with the adnasalia . . . **Epaphius* Stephens.

29(28). Nasale with the lateral lobes forming an obtuse or right angle (with rounded apex), the base of the shallow concavity between the median and lateral lobes considerably anterior to level of adnasalia *Trechus* Schellenberg and **Duvalius* Delarouzée.

(No reliable characters distinguishing these two large genera are known. Species with distinct ocelli and well-pigmented tergites may generally be regarded as *Trechus*, whereas in *Duvalius* usually the mouth-parts and legs are more slender.)

10. Bembidiini.

Frontal piece not reaching hind margin of head. Cervical keel absent. Nasale somewhat produced and denticulate. Antennae not longer than the mandibles, with few setae. Mandibles rather slender, with a simple retinaculum and a penicillus. Maxillae: inner lobe absent, outer lobe with the joints subequal, or, more commonly, the second joint much longer, palpi with the joints elongate, not subdivided. Ligula small, bisetose, both joints of the labial palpi long, the apical ones very slender, not subdivided. Legs with one strong claw. Abdominal sclerites incomplete, tergites not margined laterally. Cerci rigid, leathery, slender, with rather weak setiferous nodules on outer and dorsal surfaces, evenly rounded interiorly, more or less converging at apex.

1 (4). The small dorsal seta of the tarsus at or slightly beyond basal third, always before middle (fig. 44). The apical joint of the outer lobe distinctly, usually much, less than twice as long as the sclerotised part of the basal joint.

2 (3). Nasale very broadly and shortly produced and truncate (but slightly convex and denticulate in first stage, fig. 25), its lateral limit strictly angular, its front margin more than twice as long as the epicranial suture. The latter short, not quite as long as the basal joint of the outer lobe. The two joints of the outer lobe subequal. Head rather short, slightly broader than long in median line. The small dorsal seta of the tarsus at basal third (fig. 44). First stage with a few distinct spines (2–6 on either side) as egg-bursters, two of them on either side at least as long as the diameter of the largest setiferous pores of the head (fig. 64) . . . . *Asaphidion* Gozis.

3 (2). Nasale narrower, truncate[26] or more or less projecting in middle (fig. 24), its front margin less than twice as long as the epicranial suture, or the second joint of the outer lobe much longer than the basal joint. Epicranial suture longer than the sclerotised part of the latter or at least of the same length. First stage with about 15–20 inconspicuous, minute spinules on either side of hind part of frontal piece, the longest of them hardly half as long as the diameter of the largest setiferous pores of the head (fig. 63) . *Bembidion* Latreille.

4 (1). The small dorsal seta of the tarsus in, or slightly beyond, middle (fig. 38). The apical joint of the outer lobe almost or fully twice as long as the sclerotised part of the basal joint (fig. 46). Epicranial suture shorter than the first antennal joint
Tachys Stephens 5 (next couplet)

5 (8). Cutting edge of mandibles denticulate.

6 (7). Retinaculum on basal fourth. No ocelli. (*T. bistriatus* Duftschmid; *ex* Xambeu) . . . . *subgenus *Tachys* s.str.

7 (6). Retinaculum at two-fifths from base. Ocelli present.
subgenus *Mioptachys* Bates ?

8 (5). Cutting edge of mandibles smooth.

9(10). Retinaculum basad of middle. Nasale slightly projecting, the front margin of clypeus denticulate over two-thirds of its length (between the angles), the outer two or three denticles on either side rather large and almost as much projecting as median part (fig. 26). Epicranial suture distinct though short, shorter than the second antennal joint . . . . subgenus *Tachyta* Kirby.[27]

10 (9). Retinaculum in middle of cutting edge. Nasale more strongly projecting.

11(12). Epicranial suture distinct, almost as long as second antennal joint. Nasale more sharply projecting, front margin truncate, reaching lateral margins in an obtuse angle, its denticles extending to close to angles (over at least two-thirds of the front margin)
subgenus *Tachyura* Motschulsky pars (*vivax*, *incurvus*).

12(11). Epicranial suture extremely short, almost wanting. Nasale broadly rounded and denticles not extending beyond it, thus hardly half the front margin of clypeus denticulate (*ex* Cerruti)
subgenus **Tachyura* Motschulsky pars (*parvulus*).

12. Broscini.

Frontal piece not reaching hind margin of head (except *Cnemacanthus* ?). Clypeus with the median part produced and truncate (except *Cnemacanthus* ?).

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[26] If broadly and rather deeply emarginate, see "*Bembidion* sp. ? or genus indet." in list of material, p. 63.

[27] The characters mentioned in my keys (1919 and 1921 :—two claws, very short cerci, 6 ocelli) were taken from Xambeu's description and are, no doubt, quite wrong.

Antennae not longer than the mandibles, the first joint longer than the second and third. Cutting edge of mandible and retinaculum smooth. Maxillae: outer lobe with the second joint not more than two-thirds as long as the first (except *Cnemacanthus* ?); palpi with the second joint at least two-thirds as long as the first, about twice as long as the third. Labial palpi with the second joint conspicuously shorter than the first. Legs with one strong claw (except *Cnemacanthus* ?). Sclerites not complete. Cerci rigid, leathery, with rather strong setiferous nodes (except *Cnemacanthus* ?).

1 (4). One claw. Maxillary stipes not transversely divided. Cerci and retinaculum well developed. Frontal piece not reaching hind margin of head.

2 (3). Tergites not margined at sides (except anteriorly). Cerci much longer than tenth abdominal segment. Inner lobe absent. Penicillus of mandibles present, retinaculum rather strong, about two-thirds as long as the diameter of the mandible at distal end of retinaculum. Terminal joint of maxillary palpus and outer lobe hardly half as long as preceding joint, that of palpi strongly, that of the outer lobe slightly tapering to apex. Claws (fig. 39) with a pair of very conspicuous short spines on ventral surface of base (easily visible in all stages at a magnification of eight times by means of a hand-lens). Nasale simply truncate and slightly rounded or with three small teeth . . . . *Broscus* Panzer.

3 (2). Tergites margined at sides. Cerci hardly longer than tenth abdominal segment. Inner lobe present and distinct. Penicillus of mandibles absent, retinaculum small, about one-third as long as the diameter of the mandible at distal end of retinaculum. Terminal joint of maxillary palpus and outer lobe slightly more than half as long as preceding joint, that of palpi slightly, that of outer lobe not, tapering to apex. Claws without a pair of spines on ventral surface of base. Nasale truncate and denticulate . . . . *Axonya* Andrewes.

4 (1). Two claws. Maxillary stipes transversely divided in apical half. Cerci vestigial, very short, broad, hump-like, without setiferous nodes. Retinaculum very small. Frontal piece broadly reaching hind margin of head. Nasale hardly produced, broadly rounded (figs. 90–97) . . . . *Cnemacanthus* Gray ?

13. Patrobini.

Frontal piece not reaching hind margin of head. Cervical groove and keel present. Adnasalia not reaching level of nasale. Antennae not longer than mandibles, with few setae, the first three joints subequal, the second sometimes slightly longer. Retinaculum small, its cutting edge smooth, penicillus near base of mandible absent. Maxillae: inner lobe absent, palpi with the first joint shorter than the other two combined, the second joint distinctly or much longer and stouter than the third. Ligula small, bisetose, second joint of labial palpi shorter than the first. Legs with two strong, equal claws. Sclerites not complete, tergites margined at sides. Cerci rigid, leathery, rather long and slender, with rather strong setiferous nodes.

1 (2). Head with a pair of deep ventro-lateral furrows from ventral articulation of mandibles to the cervical groove and continuous with it. The two joints of the outer lobe subequal, second joint of labial palpi slightly shorter than first. Adnasalia acute exteriorly, nasale rather strongly produced, slightly trilobed, well defined from adnasalia. Maxillary palpi slender, a third shorter than the stipes (*ex* Schiödte) . . . . **Patrobus* Stephens.

2 (1). Head without deep ventro-lateral furrows, at most with a shallow depression in their place. Second joint of outer lobe distinctly shorter than first, second joint of labial palpi at most two-thirds as long as first. Adnasalia strongly obtuse, nasale slightly produced, truncate, with a small or indistinct, bluntly pointed prominence in middle. Maxillary palpi robust, about half as long as stipes.

3 (4). Neck not inflated, conspicuously narrower behind cervical keel than the head at base of antennae and, especially, temples. Nasale distinctly though not abruptly produced, the median prominence distinct . . . . *Deltomerus* Motschulsky.

4 (3). Neck distinctly inflated, not narrower than the head at base of antennae and not much narrower than head at widest point (on temples). Nasale hardly produced, not defined from adnasalia, the median prominence indistinct (always ?) . . . . . *Diplous* Motschulsky.

14. Pterostichini.

Epicranial suture usually well developed, frontal piece very seldom reaching hind margin of head, and then only at a point. Cervical groove and keel present (except in *Evarthrus* and *Feronia* (*Steropus*) *globosa* Fabricius ?). Antennae not, or not much, longer than mandibles, with few setae, first joint longer than second, third with a distinct appendage. Mandibles at least three times as long as wide at base, retinaculum and penicillus (*Molops* ?) present. Maxillae: inner lobe present (except in some *Drimostomina*, *Cratocerina* ? and *Abacetus*). Ligula small, seldom absent, the two setae always present. Legs with two strong, equal claws (except in some *Abacetus*). Abdominal sclerites not complete, tergites margined at sides (*Coelostomus* ?, margin obsolete in *Evarthrus*). Cerci fixed, leathery, rather long and slender, with setiferous nodes, sometimes jointed or almost jointed except in basal part.

1 (8). Inner lobe vestigial (fig. 54) or absent. If two equal claws are present, the posterior row of ocelli consisting of only one (the lower) ocellus.[28] Ligula distinct. Epicranial suture rather long.

2 (3). Claws very unequal, or only one claw present. Six ocelli. Nodes of cerci not very strong. Nasale very slightly produced at sides, the front margin broadly emarginate and irregularly crenulate
Abacetus Dejean pars a.

3 (2). Two equal claws present. Four ocelli. Nodes of cerci rather strong. Nasale broadly and shortly produced, truncate or slightly convex in middle. Mandibles not very slender, about thrice as long as wide, retinaculum rather short, curved inward and forward.

4 (7). Nasale defined at sides by a distinct single denticle; adnasalia with obtuse angles. Cutting edge of mandible smooth between retinaculum and apex (Drimostomina).

5 (6). Tibiae only with the apical whorl of fossorial setae (and the normal dorso-basal tactile seta). Inner edge of retinaculum crenulate. Second antennal joint not longer than fourth, not much longer than wide . . . . *Coelostomus* McLeay.

6 (5). Tibiae (fig. 100) with an antero-ventral fossorial seta in addition to the apical whorl (and to the dorso-basal tactile seta). Inner edge of retinaculum smooth. Second antennal joint much longer than fourth and much longer than wide . . . . . *Diceromerus* Chaudoir.

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[28] Inner lobe vestigial; two equal claws and six ocelli present; cutting edge of mandibles serrate; tergites not margined at sides; see *Leptotrachelus* (Colliurini, Ctenodactylina).

7 (4). Nasale evenly and rather strongly denticulate, without an isolated denticle marking its outer ends; angles of adnasalia bluntly pointed exteriorly. Cutting edge of mandible finely crenulate between retinaculum and apex. Tibiae only with the apical whorl of fossorial setae (and the dorso-basal tactile seta). Inner edge of retinaculum smooth. Second antennal joint not longer than fourth, hardly longer than wide (Cratocerina ?) . . . . *Cratocerus* Dejean ?

8 (1). Inner lobe present (figs. 52, 55), seldom very short[28] (fig. 47), (but then two equal claws and either six or no ocelli present. Cutting edge of mandibles not serrate, or tergites margined laterally, usually both.

9(30). Seta of inner lobe apical (fig. 52, a, b), though the extreme apex of the lobe may be produced above its base into a microscopical spine. Stipes maxillaris without trace of a membranous transverse area on ventral surface, except in *Platyderus* ? (Anchomenina).

10(25). Ocelli absent, indistinct, very small, or normal, but then the epicranial suture much shorter than the fourth antennal joint. Second joint of maxillary palpi much shorter than first, subequal to third. Inner lobe small to very small (except *Platyderus* ?). Meso- and metanotum and tergites very pale (except in some *Calathus*).

11(14). Epicranial suture absent or practically absent, not or hardly (in larvae with a head-width of more than 3 mm.) longer than the diameter of the fourth antennal joint. Ocelli present, the pigmented spot small, especially in those of the second row. Retinaculum very small, up to a third as long as the mandibular diameter just beyond it. Tergites always very pale.

12(13). Epicranial suture very short but distinct. Ligula absent (but setae present). Retinaculum a quarter the length of the mandibular diameter just beyond it. Nasale truncate or slightly prominent (first-stage larva) in middle, never emarginate . *Sphodrus* Schellenberg.

13(12). Epicranial suture absent; frontal piece reaching hind margin of head (or at least marginal ridge) at a point. Ligula very small but distinct as a small, sclerotised cone. Retinaculum about a third as long as the mandibular diameter just beyond it. Nasale emarginate in middle . . . . *Pristonychus* Dejean.

14(11). Epicranial suture short but distinct, always longer than diameter of fourth antennal joint.

15(16). Ocelli absent. Antennae very slender. Retinaculum strong (*ex* Xambeu). Larvae in caves of the Alpes Maritimes and Piedmont (perhaps occasionally in the open under deeply embedded stones) **Sphodropsis* Seidlitz.

16(15). Ocelli present (always ?).

17(24). Inner lobe not or hardly longer than wide. Ligula narrow and small.

18(21). Inner lobe coniform though small. Ocelli usually small, especially those of the second row, less often normal, but then the ligula very small, tuberculiform. . . . *Laemostenus* Bonelli 19 (next couplet).

19(20). Ocelli very small, especially those of the second row subgenus *Antisphodrus* Schaufuss and *Ceuthosphodrus* Jeannel.

20(19). Ocelli normal, well developed . . . . . . subgenus *Laemostenus* s.str.

21(18). Inner lobe very short, ring-shaped (fig. 47). Ocelli normal. Ligula distinct, shortly styliform.

22(23). Nasale with a median and two paramedian emarginations, thus forming four slight lobes. . . . . *Calathus* Samouelle.

23(22). Nasale produced into a slight point (" légèrement avancée en pointe "). Coxae at base with a large black spot. Frontal piece with a double row of punctures before hind end (*ex* Xambeu). **Synuchus* Gyllenhal.[29]

24(17). Inner lobe more than twice as long as wide, subcylindrical. Ligula larger than usual, semicircular, as wide as base of labial palpi. Stipes maxillaris with a narrow transverse membranous band in basal half. Nasale truncate . . . . *Platyderus* Stephens ?

25(10). Six ocelli present and of normal size. Epicranial suture never conspicuously shorter than the fourth antennal joint, except sometimes in first-stage larvae. Second joint of maxillary palpi at least three-fifths the length of the first (fig. 52a).

26(29). Cerci not segmented though often with an incomplete membranous ring beyond each setiferous node. Inner lobe well developed (fig. 52). Nasale without conspicuous paramedian teeth.

27(28). Nasale shortly triangular, not laterally defined by a denticle. Second joint of maxillary palpi conspicuously shorter than first. Inner lobe very short . . . . *Odontonyx* Stephens.[29]

28(27). Nasale broadly subtruncate or somewhat convex or biconvex with a median emargination, or dentate, but always laterally defined by an acute or blunt denticle . *Agonum* Samouelle, **Orthotrichus* Peyron.

29(26). Cerci six-segmented, basal joint fixed, the membranous rings complete, narrow and well defined. Inner lobe vestigial, tuberculiform. Nasale with four conspicuous teeth, the two paramedian ones adjacent, twice as close together as the paramedian and outer teeth of each side. Tergites very distinctly margined at sides (cf. *Thyreopterus* ?).

30 (9). Seta of inner lobe lateral (fig. 55, see fig. 50). Stipes maxillaris with a membranous transverse area in basal half, which is almost always distinct at least on outer part of ventral surface.

31(32). Anterior margin of clypeus slightly concave in its entire width, denticulate. Inner lobe fixed (?, ex fig.). Retinaculum directed inward and backward (*ex* Gardner) . . . **Abacetus* Dejean pars b.

32(31). Nasale usually distinctly produced, at least its lateral limits, though often broadly emarginate. Inner lobe articulating at stipes (Pterostichina).

33(40). Antennae (fig. 56) with a small auxiliary (fifth) segment at base.[30] Cervical groove not sharply bent forward nor prolonged forward on ventro-lateral surface.

34(35). Cerci with about 9 long and strong primary (?) setae and, besides, with very numerous erect setae which are shorter than the primary ones but much longer than the diameter of the cerci; the latter rather stout, only slightly nodose and rather strongly curved inward,

[29] The first stage of *Odontonyx* (= *Olisthopus*) would fit *Synuchus* in this key owing to its larger last antennal joint, but only the normal black, comma-shaped spot is present at the outer side of the base of the coxae, and the double row of punctures before the hind end of the frontal piece is absent. These two characters, however, which Xambeu emphasises, are rather problematic, and the larva of *Synuchus* may perhaps also be traced to *Odontonyx*. It can, thus, hardly be expected that these two genera can reliably be distinguished at present.

[30] This character is at the same time so unambiguous, unusual, and obviously important, that I cannot withstand the temptation to separate the whole group with accessory joint from the rest of *Feronia*, thus including *Abax*, *Molops*, *Evarthrus* and *Eumolops* in a group opposed to it. As the fifth antennal segment is present in first-stage larvae of *Abax*, it may be expected also in all three stages of the other groups. The character of the adults, corresponding with the auxiliary joint, would seem to be the absence or presence (in nearctic species) of only one pore in the third interval of the elytra, and it may, therefore, be expected that the *Hypherpes*-group will present the same larval character. In the remaining group *Feronia* with two or more punctures in the third interval a number of palearctic species occur, in which only a single pore is present. In these cases the single puncture is usually the last one, whereas in *Evarthrus* it is the second pore.

hardly tapering to apex. Mouth-parts as in *Abax* and *Molops*: mandibles very slender, retinaculum spine-shaped, directed inward and basad, inner lobe (which is longer) with a small lateral seta, second joint of maxillary palpi long and cylindrical, about thrice as long as third. Ligula broad and truncate. Nasale broadly and shortly produced, evenly emarginate over its entire width, its outer end tooth-shaped and a small similar denticle just to its inner side genus indet 3.

35(34). Cerci with only about 4–10 long setae or in addition with short, erect pubescence, which is much shorter than the diameter of the cerci.

36(37). Cerci jointed in more than apical half, the joints very well defined all round, the segments with the normal strong setae and all but the basal 1–2 minutely pubescent (fig. 99), the pubescence being most conspicuous on the last segment. Mouth-parts, especially mandibles, very slender and long. Inner lobe very short with a small lateral seta. Nasale broadly but rather strongly produced, truncate, with straight front margin and oblique sides, the latter with a tubercle or blunt tooth near middle. Ligula very short or indistinct *Abax* Samouelle.

37(36). Cerci not jointed nor pubescent. Maxillary stipes rather short.

38(39). Cervical groove and keel present, but sides of head almost straight in outline. Cerci slender, several (about 5–6) times as long as the ninth tergite on median line, narrowly rounded at apex, with more numerous (*c.* 8) setae, at least in the second and third larval stages. Nasale broadly truncate, front margin smooth with a deep, rounded-triangular median excision, adnasalia not projecting, with a row of about six strong setae along front margin (fig. 30). Seta of inner lobe minute, not, or hardly, passing its apex (fig. 55). Stipes maxillaris robust, less than thrice as long as wide. Ligula indistinct. Antenna fig. 56 . . . . *Molops* Bonelli.

39(38). Cervical groove absent, neck not defined from temples. Cerci short and rather stout, not or not much longer than ninth tergite on median line, rather broadly truncate at apex, with only three setae beside the apical ones. Nasale denticulate on front margin, which is straight, without a median excision. Seta of inner lobe passing its apex. Epipleurites divided into two parts, the anterior one smaller. Tergites with vestigial side-margins (at least in full-grown larva) . . . . *Evarthrus* Leconte.

40(33). Antennae four-jointed, without a small auxiliary basal joint. Nasale more or less denticulate on front margin, often emarginate in middle, but never with a deep median excision. Cerci not jointed.

41(42). Cerci rather strongly diverging at base, strongly incurved and hardly tapering from middle to apex, the nodes very broad and flat (fig. 71). Lateral marginal ridge of the first to eighth tergites strongly though evenly dilated from fore to hind end, their inner edges conspicuously converging behind (fig. 71). Penicillus of mandible minute. Cervical groove and keel not sharply bent foward nor prolonged on ventro-lateral surface of head. Nasale broadly convex. Every tergite with a few minute setae but only one strong one on either side, the latter to the inner side of the hind end of the marginal ridge . . . . *Trichosternus* Chaudoir.

42(41). Cerci subparallel or slightly diverging, not strongly incurved at apex, the nodes well developed (fig. 70). Lateral marginal ridge of each tergite not or only slightly dilated to hind end, the inner edges diverging or subparallel towards hind end (fig. 70). Penicillus of mandible well developed . . . *Feronia* Latreille 43 (next couplet).

43(44). Cervical groove not briskly bent forward nor prolonged on ventrolateral surface of head, sometimes absent. Nasale rather conspicuously projecting, with or without a median emargination
subgenus *Steropus* Stephens pars a.

44(43). Cervical groove briskly bent forward on ventro-lateral surface of head and more or less prolonged forward to level of ocelli or beyond.[31]

45(46). The ridge to the outer side of the strong dorsal setae of the parietalia is strongly raised in its posterior part and forms an elongate swelling (fig. 23). Retinaculum minute, not longer than the diameter of the fourth antennal joint. Nasale very broad, rather strongly produced, front margin concave over its entire width
subgenus *Feronia* s.str. (*Poecilus* Samouelle).

46(45). The ridge to the outer side of the strong dorsal seta of parietalia not forming a swelling behind. Retinaculum usually longer than diameter of fourth antennal joint, as a rule much longer.

47(48). Tergites with only one pair of strong setae in the posterior row, to the inner side of the marginal ridge. Stipes maxillaris without a membranous area near base of ventral surface. Retinaculum half as long as mandibular diameter just beyond it. Nasale truncate, slightly narrower than adnasale, somewhat produced
subgenus *Pseudorthomus* Chaudoir?

48(47). Tergites with 2–3 pairs of more or less strong setae in the posterior row. Stipes maxillaris with a membranous area near base of ventral surface (see fig. 23), except sometimes in first stage.

49(52). The outer limits of the nasale (defined by the outer ones of the four spinules above front margin) strongly projecting, the nasale either truncate or broadly emarginate between them. Retinaculum rather short, considerably shorter than the diameter of the mandible just beyond it.

50(51). Nasale emarginate over its entire width, the outer limits rounded, the adnasalia concave
subgenera *Omaseus* Stephens, *Parargutor* Casey, *Refonia* Casey.

51(50). Nasale truncate over its entire width, sometimes very shallowly emarginate in middle, the outer limits angular or tooth-shaped.
subgenera *Bothriopterus* Chaudoir, *Argutor* Stephens, *Pseudomaseus* Chaudoir, *Euferonia* Casey, ? *Lyperosomus* Motschulsky.

52(49). The outer limits of the nasale not or very slightly emphasised, or the nasale projecting beyond them. Retinaculum often very long, always rather slender.

53(56). Nasale wider than each adnasale, at most moderately projecting.

54(55). Nasale not projecting beyond its lateral limits
subgenera *Pterostichus* Stephens (*multipunctatus*), *Steropus* Stephens (*aethiops*), *Dysidius* Chaudoir.

55(54). Nasale distinctly projecting beyond its lateral limits
subgenus *Pterostichus* Stephens (*melas*, *cristatus* ?).

56(53). Nasale not wider than each adnasale, strongly projecting
subgenus *Abacidus* Leconte.

16. Amarini.

Nasale with 4–6 small, subequal teeth which are never separated by more than their own width, rest of nasale denticulate, adnasalia not or slightly produced. Antennae not much longer than mandibles, with few setae.

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[31] The following key to the subgenera of *Feronia* must necessarily remain very tentative, as only a few of the numerous subgenera are available and, even of those, mostly only a single reliably identified species. No attempt has, therefore, been made to separate the representatives at hand of every single group.

Mandibles robust, not more than twice as long as wide, with a small retinaculum and a penicillus. Maxillae with the stipes divided transversely near middle by a membranous zone, the apical part with a longitudinal, comb-like row of strong, inwardly directed setae on dorsum; inner lobe present, with a lateral seta. Ligula well developed, with two setae. Tarsi with two subequal claws. Tergites not margined laterally. Cerci fixed, with some setiferous nodules, very short to moderately long.

Amara Samouelle.

1 (8). Ninth ventrite without a pair of setae at middle of its length.

2 (3). Nasale with four somewhat stronger teeth, which are distant from each other by approximately their own width. Cervical groove absent, but sometimes indicated by a distinct angular bend in the outline of the temples, which is caused by a rudimentary ridge. Cerci shorter than the ninth tergite and the tenth abdominal segment (at least in full-grown larvae). Head very broad, almost twice as broad as the frontal piece is long. Epicranial suture short, but very distinct . . . . subgenus *Percosia* Zimmermann.

3 (2). Nasale with (5–)6 very small and closely set teeth (fig. 10), seldom (*Celia quenseli*) as in *Percosia*, but the cerci always longer than the ninth tergite.

4 (7). Epicranial suture very distinct, cervical groove present. Egg-bursters of first-stage larva keel-shaped.

5 (6). Cervical groove present only on lateral part of dorsum, just reaching the sides of head, but not cutting through its outline, more strongly curved forward at sides. Epicranial suture long, at least as long as fourth antennal joint. Head rather strongly rounded-narrowed near base. Larger species . . . . subgenus *Cyrtonotus* Stephens.

6 (5). Cervical groove extending well on to lateral surface of head, both groove and keel cutting the outline. Epicranial suture shorter subgenus *Amara* s.str.

7 (4). Epicranial suture absent or practically absent (see fig. 10). Egg-bursters of first-stage larva spine-shaped (see fig. 67). Cervical groove present or absent, perhaps sometimes (*quenseli*?) replaced by a distinct angular bend in the outline of the temples and a slight impression in front of it . . . . . subgenus *Celia* Zimmermann.

8 (1). Ninth ventrite with one or several pairs of setae, at middle of its length, which are longer than the paramedian pair of small setae of the posterior row. Head without a cervical groove and keel (fig. 10). Epicranial suture absent. Head much wider than long. Nasale with (5–)6 small, closely set teeth. Egg-bursters of first stage spine-shaped (fig. 67) . . . . . . subgenus *Bradytus* Stephens.

17. Orthogoniini.

Frontal piece broadly reaching hind margin of head, epicranial suture absent. Head narrowed to base, but without a cervical groove or keel. Ocelli absent. Nasale with some rounded teeth. Antennae slightly longer than mandibles, not pubescent but rather richly setose, especially on inner surface of the first and second joints, the basal joint the longest. Mandibles stout, less than twice as long as wide, cutting edge with 1–2 blunt teeth besides the retinaculum; penicillus absent. Maxillae with the stipes stout, not divided, inner lobe present, seta apical, palpiger and basal joint of outer lobe longer than the following joints. Ligula rather long, labial palpi stout, second joint tapering to apex. Legs with a single short claw, which may be bifid, with the points unequal, or provided with an obtuse-angular dilatation at base. Tergites very small and broadly divided on median line, at least in older larvae which are physogastric, tenth segment very short and stout. Cerci absent. Termitophilous larvae, first stage unknown.

1 (2). Second joint of maxillary palpi practically as long as first, both together as long as palpiger. Second joint of labial palpi large, not much smaller than first, broadly rounded at apex . . . **Glyptus* Brullé.

2 (1). Second joint of maxillary palpi small, the first almost or fully as long as the others together (fig. 7). Second joint of labial palpi much smaller than first (much shorter as well as narrower), conical with narrowly rounded apex . . . . *Orthogonius* McLeay.

18. Harpalini.

Frontal piece not reaching hind margin of head, epicranial suture well developed. Head with a cervical groove and keel (*Amblystomus* ?). Six ocelli present. Antennae not or slightly longer than mandibles, basal joint the longest, but third sometimes almost as long. Mandibles more or less stout, usually less than two-and-a-half times as long as wide, sometimes prolonged between retinaculum and apex, the former then rather close to base and the middle part hardly curved and with several blunt teeth on cutting edge; penicillus and retinaculum present, often 1–5 blunt teeth beyond the latter. Maxillae with the stipes moderately long, inner lobe present; outer lobe and palpus slender; first joint of palpi longer (usually much) than palpiger and second and third joints. Legs with two free, unequal claws. Tergites well developed, though often rather pale; incomplete and not margined at sides; tenth segment more or less slender, abdomen not physogastric. Cerci present.

1 (2). Front margin of clypeus semicircularly excised over the entire width between the angles, margin of excision jagged. Cervical groove and keel " not apparent." Seta of inner lobe apical. Retinaculum slender and long, at basal third, directed slightly backward. (*ex* Gardner) (Amblystomina) . . . . **Amblystomus* Erichson.

2 (1). If the front margin of clypeus is semicircularly excised, this excision is defined by a pair of teeth (fig. 32) but not by the lateral angles, which are well defined, the excision thus not taking up the entire width. Cervical groove and keel distinct (figs. 11, 12). Seta of inner lobe (fig. 50) lateral (or, seldom, absent).

3(16). All the tergites behind front margin with a complete transverse keel (see figs. 70, 71), defining praetergum from tergum, and dorsal surface of first joint of labial palpi bare. Head of moderate size. Cerci much longer than the ninth abdominal tergite and conspicuously longer than the tenth segment, the latter with only six pairs of setae, arranged in two oblique rings, sometimes one or a few additional pairs of small setulae present.

4 (5). Cutting edges of mandible and retinaculum serrate. Nasale slightly protruding, with eight narrow but rather long teeth, the two paramedian ones somewhat more projecting. Posterior row of setae on tergites consisting of two pairs of strong setae. Ventral surface of femora with one pair of rows of short setae . *Dicheirotrichus* Jacquelin.

5 (4). Cutting edges of mandibles and retinaculum smooth. Nasale differently shaped.

6 (7). Inner lobe fused on ventral surface with stipes, rather broad and triangular (fig. 11). The furrow, surrounding the ocelli, not prolonged backward on dorso-lateral surface of head. Retinaculum rather small (about a third as long as the mandibular diameter

distad of it). Ligula rather broadly truncate and emarginate, its setae rather broadly separated. Nasale with the larger central portion truncate and minutely dentate, and two stronger teeth on either side of it. Nota each with two pairs of setae in the posterior row. Trochanters and femora with one row of spinules each on antero-ventral and postero-ventral surfaces . *Anisotarsus* Chaudoir.

7 (6). Inner lobe not fused with the sclerotisation of the stipes, styliform (fig. 12). Retinaculum quite strong (at least one-half as long as the mandibular diameter distad of it).

8(13). The furrow, surrounding the ocelli, prolonged backward on dorsolateral surface of head as a conspicuous groove (fig. 12). Nasale with 4–9 stronger teeth, the margin of which may be crenulate, distinctly projecting.

9(10). Inner lobe without a seta (normal ?). Ligula with a short, sclerotised, bidentate process that bears the setae. Femora with two rows of spinules each on antero-ventral and postero-ventral surfaces. Nasale shortly projecting, rounded, with five subequal teeth. Prolongation of ocellar furrow not very long nor very deep *Trichopselaphus* Chaudoir ?

10 (9). Inner lobe with a seta. Ligula simple. Prolongation of ocellar furrow very long and sharply defined.

11(12). Nasale with a single, large median tooth, though on a slightly lower level than the remaining four teeth on either side. Insertions of ligular setae contiguous, conspicuously sclerotised. Trochanters and femora with two rows of spinules each on antero-ventral and postero-ventral surfaces. Nota each with two pairs of setae in the posterior row. Lateral part of mentum not very densely and more coarsely granulate . . . . *Anisodactylus* Dejean.

12(11). Nasale with a median rounded excision and, on either side, two broad, truncate teeth with crenulate front margins (fig. 12). Insertions of ligular setae not contiguous, rather broadly separated, very narrowly sclerotised. Trochanters and femora with one row of spinules each on antero-ventral and postero-ventral surfaces, the femora with one additional pair of spinules near middle, which are less distant from each other. Nota each with a single pair of setae in the posterior row, level with the lateral margins of the (abdominal) tergites. Lateral part of mentum densely and finely granulose . . *Amphasia* Newman.

13 (8) The furrow, surrounding the ocelli, not prolonged backward on dorsolateral surface of head, or indistinct. Nasale with more or less numerous small teeth.

14(15). Tergites with two pairs of strong (and a few small) setae in the posterior row. Nasale with ten stronger and numerous fine teeth, eight stronger teeth lying in the upper row, and separated on the median line by a somewhat broader gap, in which the two strongest teeth of the lower row are visible (*ex* Kemner) . . **Trichocellus* Ganglbauer.

15(14). Tergites with only a single pair of strong setae each, the lateral one of the posterior row, and with a few very minute setulae. Nasale (fig. 28) with two strong denticles on either outer end, the inner one of them closely adjacent to 2–3 other moderately strong denticles, the median portion emarginate and finely denticulate, a few small denticles to the inner and outer side of the outermost of the stronger teeth . . . . *Diachromus* Erichson ?

16 (3). The posterior tergites (usually all but the anterior two or three), especially the fifth to eighth, without a transverse keel defining praetergum (figs. 77, 78), though sometimes a suffused darker transverse

line may be present, which, however, does not show in profile; seldom with a very fine keel, but then the dorsal surface of basal joint of labial palpi with one or several setae in apical half.

17(30). Ligula subquadrate, broadly truncate at apex, the bases of the setae rather widely separated (fig. 60). Nasale with 1–2 large teeth or denticulate, but then not evenly rounded or the denticles larger exteriorly.

18(19). Mandible strongly prolonged distad to the retinaculum, saw-shaped, with five blunt teeth (fig. 58). The furrow, surrounding the ocelli, not prolonged backward on dorso-lateral surface of head (see fig. 11). Stipes maxillaris and labial palpi very slender. Sclerites dark brown, apical parts of legs and of cerci whitish. Clypeus broadly and shallowly emarginate between the lateral angles, front margin pale, with very minute denticles. Tenth abdominal segment with only five pairs of setae (first stage only?) . . . *Barysomus* Dejean?

19(18). Mandible not or slightly prolonged (fig. 59), without or with only 1–3 blunt teeth distad of the retinaculum. The furrow, surrounding the ocelli, usually conspicuously prolonged backward on dorso-lateral surface of head (see fig. 12), always very sharply defined, if mandibles with several teeth. Nasale more conspicuously denticulate or dentate.

20(23). The seta of the cerci, preceding the apical two strong setae, is not or only slightly more distant from the latter than these from each other and is inserted on the dorso-interior surface (fig. 77); cerci shorter than the tenth abdominal segment, widely separated at base. Dorsal surface of basal joint of labial palpi with strong erect setae over its entire length. The combined second and third joints of the maxillary palpi shorter than the first. Mandibles without a tooth beyond retinaculum. Trochanters and femora with two to three rows of strong spinules each on antero-ventral and postero-ventral surfaces.

21(22). Apical group of cerci consisting of three setae (minute setulae disregarded), the next (dorso-exterior) seta being almost twice as distant from the dorso-interior one as this from the subapical one. Cerci slenderer, half as long as tenth abdominal segment, not longer than the ninth tergite; tenth segment with numerous, irregularly arranged setae all round. Tergites with a very fine transverse keel, separating praeterga from terga. Nasale very wide and broadly rounded or truncate with a median emargination, hardly produced, the outer end with 1–2 small teeth. The combined second and third joints of maxillary palpi hardly one-half as long as first. *Euryderus* Leconte.

22(21). Apical group of cerci consisting of four setae, a dorso-exterior seta being hardly more distant from the dorso-interior one than this from the others (fig. 77). Cerci stouter, two-thirds the length of the tenth segment and longer than ninth tergite; tenth segment with only a few secondary setae in addition to the normal six setae on either side. Tergites without a transverse keel. Nasale with a large, rounded median tooth and two small rounded teeth on either side. The combined second and third joints of the maxillary palpi two-thirds the length of the first . . . . . . *Cratacanthus* Dejean.

23(20). The seta of the cerci, preceding the two strong (and often one small) apical setae is at least twice as distant from them as the two strong apical setae from each other, and is inserted on the ventral surface, the next-preceding seta is separated from it by a similar distance and inserted on the exterior surface (fig. 78); cerci longer and slenderer, less broadly separated at base, gradually incurved, and usually not, or not much more, distant from each other at apex than at base. First joint of labial palpi seldom with any setae in basal half, but usually with 1–3 towards apex . *Harpalus* Latreille 24 (next couplet).

24(25). Nasale with two very large teeth, which pass the level of the adnasalia, and which are separated by a more or less semicircular excision which is usually much broader than one tooth, the excision at most minutely denticulate, the outer surface of the teeth often more strongly dentate (fig. 32). Cutting edge of mandibles simple beyond the retinaculum (figs. 59, 50, 60) . . . subgenus *Ophonus* Stephens.

25(24). Nasale with smaller teeth; if two of these are rather large, they do not pass the level of the adnasalia.

26(29). Head with the sides strongly converging to base and rather straight. Cutting edge of mandibles with 2–3 blunt teeth beyond the retinaculum. Mandibles rather straight interiorly in the dentate part. Nasale minutely denticulate, much behind level of lateral angles, forming a broad excision between the latter with the base almost straight. Postocular longitudinal groove defined by a keel on outer side.

27(28). Nasale with about two much larger though still small denticles on either side of the denticulate part. (Fig. 78) subgenus *Pseudophonus* Motschulsky.

28(27). Nasale minutely denticulate, even exteriorly . subgenus *Pardileus* Gozis.

29(26). Sides of head less strongly converging to base, head less broad. Cutting edge of mandibles without or with one tooth beyond the retinaculum, very seldom with two teeth; mandibles more regularly curved in apical part, more robust. Nasale often more or less produced, sometimes denticulate, but the denticles then larger subgenus *Harpalus* s.lat.

30(17). Ligula small, shortly styliform and obtusely conical, narrowly truncate or bidentate, with the bases of the setae subcontiguous (fig. 61). The furrow, surrounding the ocelli, not prolonged backward (see fig. 11). Cutting edge of mandibles not toothed beyond the retinaculum, the latter almost at middle. Basal joint of labial palpi without setae.

31(32). Second joint of outer lobe less than half as long as first. Tenth abdominal segment with rather numerous setulae. Median tooth of clypeus rounded in middle, with the edge denticulate in very fresh specimens, and with two small denticles on either side, two somewhat stronger denticles to their exterior side (the whole median part being very similar to that of *Harpalus aeneus* L.). Head-capsule narrowed to base, conspicuously wider than long (all in). Third joint of maxillary palpi very small, slightly shorter than the second joint and less than twice as long as wide; second joint of outer lobe up to about half as long as first joint. Fourth antennal joint shorter than second . . . . *Agonoderus* Dejean.

32(31). Second joint of outer lobe at least half as long as first. Tenth abdominal segment with six pairs of setae and 1–2 pairs of setulae.

33(34). Nasale with a pair of irregularly shaped, crenulated paramedian teeth, which are separated by a few sharp denticles; exteriorly the median part of the clypeus is irregularly crenulate-denticulate with a stronger denticle at a somewhat higher level about half-way between middle and anguli frontales. Second joint of maxillary palpi much longer than wide, as long as third. Second joint of outer lobe distinctly shorter than first. Seta of inner lobe very close to its base. Fourth antennal joint at least as long as sclerotised part of second *Bradycellus* Erichson.

34(33). Nasale without strong paramedian teeth, either rather evenly denticulate, or with a strong median tooth.

35(36). Head-capsule narrowed to base, wider than long. Nasale with a large median tooth, which is slightly dilated to apex, truncate and somewhat emarginate, at the outer side of it some denticles (*ex* Schiödte). Second joint of maxillary palpi much longer than wide, slightly longer than third. Second joint of outer lobe half as long as first . . . . *Stenolophus* Stephens.

36(35). Head-capsule not appreciably narrowed to base. Nasale rather evenly denticulate all over its width, without any larger teeth, one denticle on either side at a slightly higher level. Second joint of maxillary palpi slightly longer than wide (the sclerotised part not longer than wide), much shorter than third. Second joint of outer lobe practically as long as first . . . . *Acupalpus* Latreille.

19. Chlaeniini.

Head without a neck-constriction or a cervical groove and keel before base, though the head is somewhat narrowed to base and is provided with a lateral impression behind the temples. Epicranial suture absent or short. Nasale with several acute or blunt teeth. Antennae not much (up to a third) longer than mandibles, with a few setae or pubescent. Mandibles rather slender, not much less than three times as long as wide at base or longer, penicillus present. Maxillae : stipes rather slender, inner lobe strong, with an apical seta, second joint of outer lobe shorter than first. Ligula distinct, with two setae, second joint of labial palpi not very slender, often subdivided at apex. Legs with two equal, simple claws. Tergites margined laterally, complete, usually partly hiding the abdominal spiracles in dorsal view. Cerci either fixed and with a few nodules, each of which bears a seta, or fixed or movable and, in second and third stages, without nodules and with numerous small hairs, often irregularly annulate.

(The larvae of only a few genera of this tribe are known, but their generic distinction is, neverthelesss, apparently difficult, and it is doubtful whether the characters in the first and last paragraphs really separate the Chlaeniina and Oodina in a reliable way. Some of the unidentified material has, therefore, been disregarded.)

1 (8). Tergites pubescent (fig. 79). Retinaculum more or less conspicuously basad of middle, recurved, the longitudinal axis pointing towards base and interior side. Larva usually bicolorous, the head being more or less yellow, the dorsal sclerites black. (Chlaeniina.)

2 (3). Cerci with a few nodules, bearing each a long seta, fixed at ninth tergite (see fig. 70). Second joint of labial palpi without distinct apical subdivisions . . . . *Chlaenius* Samouelle pars a.

3 (2). Cerci filiform and pubescent, often multiannulate, articulating at ninth tergite (fig. 79), those of first stage as in *Chlaenius* pars a, but articulating at ninth tergite. Second joint of labial palpi subdivided at apex, ending in one (fig. 62) or two small but quite distinct jointlets.

4 (5). Ligula shorter than its setae, the ligula more or less small. Clypeus with strong or blunt teeth, often with additional denticles between or laterad of them . . . . *Chlaenius* Samouelle pars b.

5 (4). Ligula longer than its setae, the ligula rather large (after Gardner's figures). Clypeus with five rather equal blunt, rounded teeth, without additional denticles.

6 (7). First antennal joint distinctly shorter than second, antennae very slender, the joints subcylindrical. Retinaculum well developed. Maxillary stipes entire. Ligula longer than wide, labial palpi with one auxiliary apical jointlet (*ex* Gardner) . **Callistomimus* Chaudoir.

7 (6). First antennal joint distinctly longer than second, the three basal joints short, distinctly thickened apically. Retinaculum represented only by a slight swelling. Maxillary stipes subdivided across middle. Ligula large, as wide as long, labial palpi with two auxiliary apical jointlets (*ex* Gardner) . . . . **Rhopalopalpus* Laferté.

8 (1). Tergites bare, except for two transverse rows of a few short setae (two pairs in the posterior row). Retinaculum almost in middle of cutting edge, directed inward. Frontal piece not reaching hind margin of head, epicranial suture distinct though short. Tergites very broad and complete. Cerci fixed, with a few setiferous nodules. Second joint of maxillary palpi longer than first, third very small. Nasale with three small though strongly projecting teeth and a few denticles laterad of them . . . . *Oodes* Samouelle.

20. Licinini.

Frontal piece almost always reaching the hind margin of the head, epicranial suture absent or very short. Clypeus with the nasale unarmed and not reaching level of the adnasalia, not well defined from the latter, with a membranous seam (*Dilonchus*? *Badister*?) or entirely membranous. Antennae much longer than mandibles, usually twice or more than twice as long, with the normal small number of setae, not hairy, second joint subequal to first or longer. Cutting edge of mandible strongly though finely serrate (except in *Rembus*), retinaculum usually serrate interiorly, the serrations spiniform; penicillus present. Maxillae: inner lobe strong, with a seta; second joint of outer lobe subequal to or shorter than first, first and second joints of palpi subequal or the second shorter. Labial palpi stout, the second joint subconical, ligula with two setae. Legs with two strong subequal, simple claws. Tergites more or less complete at sides. Cerci rather long, with strong setiferous nodes or pubescent, fixed or (*Dilonchus*) articulating at ninth tergite. Anal crotchets absent.

1 (2). Cutting edge of mandibles and retinaculum simple. Antennae not twice as long as mandibles (fig. 15). Cerci fixed to ninth tergite, rather strongly diverging at base and curved, with a few very strong setiferous tubercles. Third antennal joint much longer than the others. Seta of inner lobe inserted at or almost at apex, second joint of outer lobe much shorter than first, third joint of maxillary palpi well developed, conical, though only half as long as second. Ligula chitinous, distinct. Tergites sharply margined at sides, epipleurites not produced . . . . *Rembus* Latreille.

2 (1). Cutting edge of mandibles always finely serrate. Antennae at least twice as long as mandibles.

3 (8). Cerci fixed, strongly diverging at base. Retinaculum strongly serrate interiorly.

4 (7). Ligula indistinct, setae strong, slightly separated at base. Adnasalia rounded exteriorly. Tergites margined at sides. Epipleurites more or less strongly projecting at their posterior end. Terminal joints of maxillary palpi and outer lobe more or less distinctly shorter than preceding joint. Larvae of moderate to large size.

5 (6). Apical two joints of antennae pubescent, second joint several times as long as the first, not shorter than the mandibles, the following two joints each of almost the same length. Cerci with numerous fine

asperities which bear minute setulae or spinules. Seta of inner lobe inserted laterally. Third joint of maxillary palpi minute, semiglobular, half as long as diameter of second, second joint of outer lobe much shorter than first. Frontal piece enclosed by epicranial halves behind, not quite reaching hind margin of head, a very short epicranial suture present. Epipleurites protruding sideways but not produced backward, without glandular orifices *Dicaelus* Bonelli.

6 (5). All the antennal joints with a small number of setae, not pubescent, second joint not much longer than first, only the third joint approximately as long as mandible. Cerci with a few setiferous nodes, otherwise bare and smooth. Seta of inner lobe inserted at apex. Third joint of maxillary palpi small, conical, as long as the diameter of the second joint, second joint of outer lobe slightly shorter than the first. Frontal piece broadly separating the epicranial halves behind, reaching hind margin of head in its full posterior width, epicranial suture entirely absent. Epipleurites protruding sideways and often produced backward, with a complicated glandular orifice near anterior end, the thoracic segments each with two pairs of glandular orifices in the pleural region, one in front and one behind *Licinus* Latreille.

7 (4). Ligula distinct as a small, chitinous, truncate cone bearing the pair of setae, which are adjacent at base. Adnasalia shortly acuminate exteriorly. Tergites not margined at sides. Epipleurites normal, not markedly projecting at their posterior end. Terminal joints of maxillary palpi and outer lobe as long as the preceding joint. Larvae of small size. Inner lobe with a lateral seta. Cerci with numerous setiferous nodules. Colours of the sclerites pale, cerci darker. (*ex* Schiödte) . . . . **Badister* Schellenberg.

8 (3). Cerci articulating at ninth tergite, pubescent and slender, rather straight. Retinaculum with an almost smooth blade interiorly. Frontal piece enclosed by the epicranial halves behind, not quite reaching hind margin of head, a short epicranial suture present. Antennal joints subequal in length, only the third longer, but not approaching the length of the mandibles, all the joints with few setae, not pubescent. Inner lobe with a lateral seta, joints of the outer lobe subequal, terminal joint of maxillary palpus much longer than the diameter of the second joint though much shorter than this joint (*ex* Gardner) . . . . **Dilonchus* Andrewes.

21. Panagaeini.

Epicranial suture absent or short, nasale entirely sclerotised (*i.e.* without a membranous seam and fringe), simply rounded (except in *Tefflus*), adnasalia receding or slightly produced (except in *Tefflus*). Antennae more than twice as long as mandibles, at least the apical two joints pubescent, third joint very slightly dilated, with the appendix at or almost at apex, all the segments long and slender. Mandibles with the cutting edge serrate (except in *Tefflus*), that of the retinaculum smooth, the latter very large, penicillus present (except in *Craspedophorus*). Maxillae: stipes more or less broad, inner lobe strong, third joint of maxillary palpi very much smaller than the preceding two. Ligula with two strong setae, the labial palpi very stout, about twice as wide as the maxillary ones. Tergites black, incomplete at sides, and not covering lateral parts of dorsum (except *Tefflus*), margined at sides, tenth segment without crotchets. Cerci articulating at ninth tergite (except in *Tefflus*), very long and slender, pubescent or with a few or many very short setae.

1 (6). Cerci movable, articulating at ninth tergite (fig. 80). Antennae four-jointed. Clypeus gently rounded in middle, without any teeth, the adnasalia often not set off from nasale, and never strongly set off (fig. 20). Frontal piece not quite reaching hind margin of head, a short epicranial suture present. Cutting edge of mandibles serrate between retinaculum and apex. Inner lobe inserted on apical end of inner margin of the stipes (except in *Craspedophorus*), normal, conical, with a strong apical seta.[32] Third joint of maxillary palpi small, but well developed, never much shorter than the diameter of the second joint. Ligula small but distinct, second joint of labial palpi more or less narrowed to apex. Tergites incomplete (Panagaeini *s.str.*).

2 (5). Second joint of outer lobe shorter than first joint and not markedly darker than it. Second joint of maxillary palpi not markedly darker than the first. Second joint of labial palpi narrowed to apex, its sensorial area subcircular (*Trichisia* ?). Cerci densely pubescent.

3 (4). Fourth antennal segment distinctly shorter than third. Ventral surface of mentum with two pairs of strong setae (one of them close to base). Adnasalia slightly receding, not reaching level of nasale, which is very broadly rounded. Cerci very distinctly tapering from base to apex, unicolorous (*ex* Gardner) . . . **Trichisia* Motschulsky.

4 (3). Fourth antennal segment much longer than any of the others. Ventral surface of mentum with only one pair of strong setae (near apex). Adnasalia slightly produced, though broadly rounded, slightly exceeding nasale, which is very broadly rounded. Cerci very slightly though quite distinctly incrassate from behind base to almost apex, the latter pale yellow . . . . *Panagaeus* Latreille.

5 (2). Second joint of outer lobe as long as or longer than first joint, and much darker than it, subconiform (fig. 20). Second joint of maxillary palpi much darker than first. Second joint of labial palpi moderately narrowed and strongly compressed in dorso-ventral direction at apex, the sensorial area elongate-bean-shaped. Cerci pubescent or with a few very short setae (fig. 80). Fourth antennal joint at least as long as third (always ?). Ventral surface of mentum with only one pair of strong setae (near apex) *Craspedophorus* Hope.

6 (1). Cerci fixed (fig. 82). Antennae with a short supplementary (fifth) joint at base (fig. 21). Clypeus more strongly projecting in middle and at sides, the nasale toothed and adnasalia denticulate at inner margin, conspicuously set off from nasale. Frontal piece reaching hind margin of head, epicranial suture entirely absent. Cutting edge of mandibles smooth. Inner lobe inserted on inner end of apical margin of stipes, broad and flattened at base, the outer edge concave, the apex pointed, the seta on inner side, small. Third joint of maxillary palpi very small, semiglobular, hardly half as long as the diameter of the second joint. Ligula indistinct (but its setae well developed), second joint of labial palpi very strongly dilated to apex, very strongly axe-shaped, the sensorial area band-shaped. Tergites more or less covering lateral parts of dorsum, at least in second and third stages, produced at each side into a raised, pointed, backwardly directed, short process (fig. 82) . . . *Tefflus* Latreille.

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[32] Schiödte describes and figures a minute lateral spine. The material at hand shows, however, that in reality the long chitinous point in his drawing is the seta. The apex of the inner lobe is somewhat obliquely truncate in the larvae of the genuine Panagaeini, and the distal (dorsal) part of the truncature is microscopically produced, though perhaps not into quite as long and thin a point as seen by Schiödte.

22. Masoreini.

Frontal piece not reaching hind margin of head, epicranial suture distinct; cervical groove and keel absent. Nasale slightly produced, truncate or broadly emarginate, angles of adnasalia obtuse. Antennae not longer than mandibles, the first joint as long as third, second short, with few setae. Cutting edge of mandibles simple, retinaculum small or moderate, simple; penicillus present. Maxillae : inner lobe absent, outer lobe with the joints simple, subequal, the second subtruncate, palpi with the first joint as long as the other two together, second only half as long as third. Labial palpi with the apical joint very slender, subcylindrical, ligula small, with two closely placed setae. Head with six well-developed ocelli, without a cervical groove or carina before base. Legs with two equal, simple claws, without pulvillus. Tergites not margined at sides, more or less pale. Cerci slender and very slightly sclerotised.

1 (2). Cerci jointed, twice as long as tenth segment. Nasale truncate, about half as wide as one adnasale. The joints of the labial palpi subequal in length. Retinaculum moderate. Claws slender and nearly straight (fig. 35) . . . . *Anaulacus* McLeay.

2 (1). Cerci not jointed, not projecting beyond tenth segment. Nasale broadly emarginate, as wide as one adnasale. The basal joint of the labial palpi nearly twice as long as the second joint. Retinaculum very small (*ex* Gardner). Claws normal (Gardner *in litt.*) *Masoreus* Dejean.

25. Lebiini.

Antennae not, or not much, longer than mandibles, with few setae, first joint conspicuously shorter than third (except *Coptodera* and gen. indet.). Mandibles with the cutting edge and retinaculum smooth, the latter often very small or absent, the former very minutely and indistinctly serrulate in *Oecornis*, penicillus always present (minute in *Coptodera*, *Cymindoidea*?). Maxillae without an inner lobe, third joint of maxillary palpi and second of labial palpi not subdivided. Legs with two claws. Tergites incomplete (except *Arsincë*), as a rule not margined at sides. Cerci absent or short or jointed, seldom with more than seven joints (in this case the head with a cervical groove and keel), seldom unjointed, leathery and with setiferous nodules.

1(30). Claws not toothed in middle (in *Plochionus* and *Catascopus*? a basal tooth is present). If the retinaculum is well developed (projecting by a third or more of the width of mandible just distad of retinaculum), the cervical groove and keel are present (fig. 19), or the first antennal joint is longer than the third. If the cerci are not jointed, either the head with a cervical groove or the retinaculum very small to absent.

2(21). Tarsus without a pulvillus and without or with a basal tooth; in the latter case the head with a cervical groove.

3(14). Retinaculum (fig. 19) very distinct or even strong, penicillus present (*Coptodera*?). Cervical groove and keel present, except sometimes if the first antennal joint is longer than the third. Maxillary stipes rather slender, almost or fully thrice as long as wide, outer lobe with the two joints subequal in length (Coptoderina).

4 (7). Epicranial suture absent, frontal piece reaching hind margin of head. First antennal joint the longest. Ligula indistinct (but its setae well developed). Anal segment without crotchets. Claws subequal, simple. Tergites not margined at sides.

5 (6). Cervical groove and keel absent. Retinaculum strong. Apical joint of labial palpi small, hardly one-half as long or as wide as basal joint, conical. Nasale narrowly produced with subparallel sides, the apex excised, thus bidentate. Cerci 8–9-segmented, the first and third joints widened exteriorly at apex and with half a whorl of long setae along outer side of apex, the second with several setae on dorsal surface of apex, the other joints with the normal setae gen. indet. 4.

6 (5). Cervical groove and keel present. Retinaculum small, but very distinct. Apical joint of labial palpi rather stout, two-thirds as long as basal joint. Nasale almost straight, not markedly projecting. Cerci four-jointed, the articulations not quite complete, except between the last joints. Tergites partly black . . *Coptodera* Dejean.

7 (4). Epicranial suture distinct, frontal piece not reaching hind margin of head, nasale dentate or markedly projecting (fig. 19). Third antennal joint the longest (though only slightly longer than first in *Thyreopterus* ? and *Catascopus* ?). Ligula (and its setae) very distinct, apical joint of labial palpi slender and subcylindrical. Retinaculum more or less strong.

8 (9). Nasale only slightly projecting, dentate (two closely adjacent teeth in middle and two others farther apart form the paramedian ones, the margin denticulate between the teeth of each side). Anal segment without crotchets. Second joint of maxillary and labial palpi not much shorter than first, third of maxillary palpi not much shorter than second. Claws simple and subequal. Retinaculum long and slender. Cerci six-jointed. Tergites margined at sides. Sclerites brown, ninth abdominal segment and apical part of cerci whitish *Thyreopterus* Dejean ?

9 (8). Nasale markedly projecting, truncate to slightly bidentate, the outer margin sometimes with a few denticles (fig. 19). Anal segment with strong crotchets on protrusible anal tubes (fig. 86). Second and third joints of maxillary palpi combined not much longer or even shorter than first, second joint of labial palpi not much more than half as long as first joint. Retinaculum shorter and stouter.

10(11). Cerci unjointed. Claws very unequal. Adnasalia somewhat produced and truncate at sides. Second and third joints of maxillary palpi combined subequal to first, second joint of labial palpi slightly more than half as long as first. Tergites not margined at sides. Head reddish, nota testaceous, tergites smoky blackish (*ex* Gardner) **Mochtherus* Schmidt-Goebel.

11(10). Cerci distinctly jointed. Adnasalia rounded, not truncate at sides. Sclerites of mesothorax to eighth abdominal segment dark.

12(13). Claws very unequal. Cerci with about six segments, some of them not completely articulated. Second and third joints of maxillary palpi combined subequal to first, second joint of labial palpi half as long as first. Tergites strongly margined at sides. Six well-developed ocellar corneae. Sclerites of mesothorax to ninth abdominal segment and most of cerci dark brown, apex of cerci pale, pronotum and head ferruginous . . . . *Lobodontus* Chaudoir ?

13(12). Claws subequal. Cerci with numerous irregular joints (fig. 86). Second and third joints of maxillary palpi combined not much more than half as long as first joint, second joint of labial palpi less than half as long as first (fig. 19). Only four distinct ocellar corneae. Tergites not margined at sides. Sclerites of mesothorax to eighth abdominal segment and most of base of cerci metallic, apical part of cerci whitish, pronotum and head brown . . . *Catascopus* Kirby ?

14 (3). Retinaculum small, vestigial or absent. Cervical grove abseont (fig. 14). First antennal joint shorter than third. Maxillary stipes robust, at most twice as long as wide.

15(18). Ligula and its two setae strongly developed. Frontal piece triangularly pointed behind; epicranial suture present though sometimes short. Cerci 5–7-jointed, including fixed basal part (but four-jointed at least sometimes in first stage). Second joint of outer lobe somewhat shorter than first. Anal tubes with distinct crotchets. 6 distinct ocelli. (Cymindina.)

16(17). Second joint of maxillary palpi shorter than either the first or third. First joint of labial palpi not much longer or even shorter than second. Retinaculum distinct, though rather small and pointing more forward than inward. Epicranial suture rather long. Nasale with two or four short and broad obtuse teeth (*i.e.* broadly emarginate in middle and sometimes also exteriorly) . . *Cymindis* Latreille.

17(16). Second joint of maxillary palpi much longer than the first or third. First joint of labial palpi much longer than second. Retinaculum absent. Epicranial suture very short. Nasale slightly produced, without teeth (possibly abraded). Cerci with 6 segments, blackish, but paler at extreme apex. (The characters of the mandibles and clypeus may partly be due to abrasion) (*ex* Gardner) **Cymindoidea* Castelnau.

18(15). Ligula and its two setae minute (fig. 14) or absent. Frontal piece reaching hind margin of head at a point, subtruncate behind and broadly rounded or shortly pointed, in the latter case its sides parallel in posterior half; epicranial suture absent. Cerci with at most four joints, including fixed basal part. (Lebiina.)

19(20). Tergites complete and broad, somewhat overhanging the lateral region (fig. 88), black. Cerci (fig. 88) not jointed, gradually tapering, pointed at apex, with a few short setulae, black and strongly sclerotised. Second joint of outer lobe shorter than the first (fig. 14). Ligula and its setae present, but minute. Anal tubes with conspicuous crotchets (fig. 88) . . . . . . *Arsinoë* Castelnau.

20(19). Tergites incomplete, leaving the lateral parts of dorsum and the sides broadly exposed, lightly coloured. Cerci 4-jointed, including the fixed base, last joint slightly club-shaped, setae well developed, though few in number. Second joint of outer lobe much longer than the first. Ligula and its setae absent. Anal tubes without crotchets. (The older larva of at least *L. scapularis* Fourcroy lives in a cocoon, with the mouth-parts embedded in its last victim, the cerci are lost and the mouth-parts, sclerotisations etc. reduced; it can no longer be recognised as a Carabid-larva from its systematic characters) . . . . *Lebia* Latreille.

21 (2). Tarsus (fig. 45) with a soft, unpaired but more or less bilobed pulvillus between the claws (if this is indistinct, the claws with a strong basal tooth). Cerci jointed. Retinaculum vestigial (fig. 57) or absent. Head without a cervical groove. Epicranial suture very short or practically absent. Hooks (fig. 81) present at protrusible anal tubes (*Onota floridana* ?). Seta of first joint of outer lobe extending beyond apex of second joint, usually very much so. (Calleidina.)

22(23). Adnasalia truncate, the front margin at right angles with the longitudinal axis, separated from nasale by a slight notch, the nasale quadridentate, hardly produced though slightly projecting beyond adnasalia. Head as long as or longer than wide, considerably narrowed with rather straight sides in basal third. Second antennal joint as long as fourth . . *Onota* Chaudoir (and *Otoglossa* Chaudoir ?)

23(22). Adnasalia obliquely rounded, passing into nasale in a broadly concave curve, rather strongly projecting above base of mandibles, the nasale produced to approximately the same level. Head often slightly wider than long, rather evenly rounded at sides, and slightly or hardly narrowed at base. Seta of first joint of outer lobe very long and far exceeding the apex of the second joint.

24(25). Claws with a long and pointed tooth at base, the apex of which projects to about middle of ventral surface. Nasale rather narrow, not much wider than long, truncate and smooth or finely denticulate at apex. Retinaculum replaced by a notch. Cerci five-jointed, but four-jointed in first stage. Sclerites pale brown in front, becoming darker behind . . . . *Plochionus* Latreille & Dejean.

25(24). Claws without a tooth at base. Nasale rather broad, at least twice as wide as long.

26(27). Nasale more or less deeply emarginate on median line, the front margin of either half with one or several emarginations. Colour of the sclerites black, the head testaceous to pale yellow, parts of the legs and cerci often white. Cerci 5-jointed, but 4-jointed in first stage, longer than tenth abdominal segment. Retinaculum present but very to extremely small . . . . . *Calleida* Latreille & Dejean.

27(26). Nasale not emarginate on median line. Cerci 4-jointed. Colour of the sclerites testaceous to pale brown.

28(29). Mandibles with an extremely small retinaculum. Nasale truncate in middle and with an emargination towards outer end, the part outward of the emargination almost as much projecting as the median part. Cerci twice as long as tenth abdominal segment . *Andrewesella* Csiki.

29(28). Mandibles with a notch instead of a retinaculum. Nasale rounded in first stage and with a small projection on each side of middle or with five rounded projections. Cerci hardly longer than tenth abdominal segment . . . . *Parena* Motschulsky.

30 (1). Claws toothed (the tooth sometimes very small (fig. 40), but always distinctly separated from base), or simple. Retinaculum and penicillus well developed, the former projecting by more than a third of the width of the mandible just apicad of retinaculum (figs. 13, 34). Nasale (figs. 33, 34) bidentate, sometimes denticulate on exterior side of base. Head (fig. 13) slightly narrowed to base, without a cervical groove or keel. Apex of tarsus without a pulvillus. Basal joint of antennae shorter than third. Fourth antennal joint longer than first and second (except in *Oecornis*, where it is subequal to them). Ligula distinct, bisetose. (Dromiina.)

31(32). Cerci shorter than ninth abdominal segment or absent (fig. 1). Anal tubes with strong crotchets. Incision between paramedian teeth not reaching level of emargination that separates the nasale from the adnasalia, outer margin of the paramedian teeth simple or with a single step or denticle (fig. 33). Abdomen often considerably broader than thorax in full-grown larvae. Each claw with a strong (and sometimes a small one in addition) or small (fig. 40) tooth *Dromius* Samouelle.

32(31). Cerci rather long, longer than both the ninth and tenth segments together, slender and leathery. Anal tubes without crotchets. Body rather parallel, gradually tapering behind middle.

33(34). Posterior claw of each leg toothed, slender, anterior claw blade-shaped and irregularly serrulate along ventral edge. Cerci finely jointed, with 5 segments besides the fixed basal part. The incision between the paramedian teeth reaches or exceeds slightly the level of the emargination that separates the nasale from the adnasalia, outer margin of the teeth simple . . . . *Risophilus* Leach.

34(33). Claws perfectly simple.

35(36). Cerci unjointed. The incision between the paramedian teeth of clypeus shallow, notch-like, the outer margins of the teeth broadly convex and serrulate or crenulate, adnasale with the front margin practically straight (inconspicuously sigmoid) between these serrulations and the angles, the latter narrowly membranous and jagged. Retinaculum of moderate length. Terminal joint of maxillary palpi and particularly of outer lobe longer than preceding joint *Metabletus* Schmidt-Goebel.

36(35). Cerci jointed, with four (first stage) or 6–7 distinct joints including basal part. The incision between the paramedian teeth of clypeus (fig. 34) deep, V-shaped, in first-stage larva reaching level of front margin, in second and third stages reaching about half-way to front margin, in the latter stages the outer side of the teeth denticulate; adnasalia with a deep and broad emargination interiorly and a broad, wholly sclerotised lobe at angles, broader than the emargination and passing slightly the level of the paramedian teeth anteriorly. Retinaculum of mandibles (fig. 34) very long, as long as diameter of mandible just beyond retinaculum. Terminal joint of maxillary palpi and outer lobe longer than preceding joint in first stage, equal or slightly shorter in third stage *Oecornis* Britton.

26. Colliurini.

Frontal piece not reaching hind margin of head, though the epicranial suture is rather short. 6 ocelli. Neck-constriction distinct though rather broad. Nasale truncate, denticulate. Antennae not or not much longer than mandibles, with few setae, third joint at least as long as first, second slightly shorter than first, appendix of third joint well developed, on exterior truncature of third joint. Mandibles moderately curved, with the cutting edge serrate apicad of retinaculum, the latter strong and simple, penicillus present. Maxillae with (Ctenodactylina) or without (Colliurina) a vestigial inner lobe. Ligula distinct, bisetose. Legs with two equal, simple claws, without pulvilli or other appendages. Tergites incomplete at sides, the latter not margined. Cerci fixed at base, slender, leathery, with three or four articulations, each just beyond a setiferous nodule.

1 (2). Nasale not produced, much wider at front margin than each adnasale. Neck conspicuously constricted, rather long, but apparently without a cervical groove or keel. Inner lobe absent. Joints of labial palpi subequal in length, the second joint much wider at base than at apex. Cerci with three distinct articulations. (Colliurina) (*ex* Rosenberg) . . . . **Colliuris* Degeer.

2 (1). Nasale slightly produced, hardly as wide at front margin as each adnasale. Neck very slightly constricted, short and broad, with a distinct cervical groove and keel. Inner lobe vestigial. Second joint of labial palpi about half as long and a third as wide as first, subcylindrical. Cerci with four articulations which are partly somewhat incomplete. (Ctenodactylina) . . *Leptotrachelus* Latreille.

27. Dryptini.

Head strongly constricted at base, forming a narrow neck, which is, however, not defined by a cervical groove or keel. Frontal piece not reaching hind margin of head, epicranial suture long. Nasale produced into a short or long horn, adnasalia prominent as short broad lobes. Antennae slender, longer than mandibles, third joint shorter than first and second, and not wider than either, the appendix very small. Mandibles slender, strongly curved, cutting edge smooth apicad of retinaculum, the latter strong, penicillus absent. Maxillae long and slender, inner lobe absent, outer lobe with the second joint very narrow and long or at least its apical part very narrow. Labium with the ligula bisetose, palpi slender. Legs long and slender, with two claws, the base of the latter with a spiniform or pulvillus-like appendix, which is usually present at each claw, but in some *Galerita* evidently only on one claw of each leg. Sclerites of abdomen incomplete, ninth tergite divided along median line. Cerci very long, basal part fixed, followed by ten or more joints, rarely by only a few very long joints (character of first-stage larvae ?).

1 (4). Horn of nasale short and broadly rounded. Head-capsule as long as wide or longer, narrowed anteriorly. First and second antennal joints subequal. Ligula membranous, short and broadly rounded. Gular suture single and distinct, ventral surface of head normal. Cutting edge of mandibles forming a rounded, prominent blade basad of retinaculum, the latter simple. Second joint of outer lobe much longer than first joint, extremely slender, rod-shaped; second joint of maxillary palpi longer than third and often first. Apical part of the claw-appendix, which is present on both claws and inserted on ventral surface of base, membranous and pale (figs. 42, 43). Tergites not margined laterally or margined only in anterior half of sides.

2 (3). Ventral sclerites of first to sixth abdominal segments free, ventrite of these segments strongly transverse, separated from the other sclerites by broad membranous areas. All the joints of the cerci equally well defined and very regular, though not of quite equal length, each segment with a seta at apex but without any other hairs. Head-capsule as long as wide. Pulvilli much shorter than claws, considerably widened at apex (fig. 43) . . . . . . *Drypta* Latreille.

3 (2). Ventrite and inner postventrites of sixth (or fifth and sixth) abdominal segment fused, those of the preceding segments more or less narrowly separated (fig. 87). The joints in the basal half of the cerci irregular, some of them very short, some not defined all round, all the joints up to apex with sparse half-erect small hairs besides the setae. Head-capsule longer than wide. Pulvilli reaching apex of claws, styliform (fig. 42) . . . . *Desera* Hope ?

4 (1). Horn of nasale very long and narrow, subparallel, bifurcate at apex (fig. 98). Head-capsule wider than long to as wide as long, widened to front end. First antennal joint very much longer than the second, at least subequal to the combined second and third joints. Ligula chitinous, narrow, and more or less projecting. Gular suture not visible, ventral surface of head much shorter than dorsal surface, transversely embossed behind labium, the embossed part defined behind by a deep transverse impression. Cutting edge of mandibles simple basad of retinaculum, but the latter sometimes with a small auxiliary tooth near apex. Second joint of outer lobe as in *Drypta* or subequal in length to the first joint but then the apex suddenly contracted and forming a short point. Second joint of maxillary palpi usually shorter than first and third joints. Appendix of claws small, spiniform, inserted on interior ventral surface of claws, sometimes present on only one of the two claws (fig. 37). Tergites narrowly margined laterally. Ventral sclerites of abdomen largely fused . . . . *Galerita* Fabricius.

29. Helluonini.

Nasale shortly produced, truncate or toothed. Antennae with few setae, very short and stout, much shorter than the mandibles, second and third joints separated only by a suture, first segment longer than any of the others, less than twice as long as wide. Mandibles less than twice as long as wide, cutting edge smooth, retinaculum rather small and stout, penicillus absent, basal half of outer surface with about 4–6 strong setae. Maxillae without an inner lobe, basal joint of outer lobe fused with stipes, densely hairy on dorso-interior surface, maxillary palpi stout, second joint the longest, stipes stout, less than twice as long as wide. Ligula chitinous, bisetose, labial palpi stout. Sclerites of thorax and abdomen complete, tergites not margined. Two simple claws. Ninth tergite divided along median line, cerci very stout, at least as broad as tenth segment, the latter stout, not much wider than long; at the tip of the stout joint of the cerci a minute pale rudiment of a second joint. Body very parallel-sided, hairy, the middle segments piceous to black, the extremities reddish.

1 (2). Claws very unequal, the posterior one about half as long and wide as the anterior one. Nasale three-toothed, separated from adnasalia by a very narrow emargination, which extends exteriorly into a tooth, the remainder truncate, the nasale thus apparently five-toothed and not separated from adnasalia. Third joint of maxillary palpi small and slender, less than half as wide as second joint. Interior postventrite separated by a narrow suture. Epipleurites not or inconspicuously emarginate at spiracles. Epicranial suture practically absent (punctiform) . . . . *Omphra* Reiche.

2 (1). Claws equal or subequal. Nasale separated from adnasalia by a strong, rounded emargination which is directly prolonged in a curved line into the adnasalia. Third joint of maxillary palpi more than half as wide at base as apex of second joint.

3 (4). Cerci conical, strongly tapering from a wide base to a blunt apex. Nasale truncate, with the anterior margin straight (possibly owing to abrasion !). Terminal segments of maxillary and labial palpi each with circular apical caps which are closely and rather coarsely granulate, almost as wide at base as apex of preceding segment. Epicranial suture present. (Prothorax testaceous red, mesothorax black) (*ex* Gardner) . . . . **Macrocheilus* Hope.

4 (3). Cerci of approximately equal width in basal half, tapering slightly in apical half or less to rounded apex (fig. 85). Nasale with two or more teeth. Terminal segments of maxillary and labial palpi soft-skinned, without a more or less rigid and granulate apical cap.

5 (6). Epicranial suture practically absent (fig. 17). Nasale with two teeth, between which the anterior margin is truncate or slightly rounded forward. Antennae scarcely half as long as mandibles, retractile. Interior postventrites fused. Abdominal spiracles placed in a deep emargination of the epipleurites (fig. 85). (Prothorax and mesothorax ferruginous) . . . . *Triaenogenius* Chaudoir ?

6 (5). Epicranial suture present. Nasale with five acute teeth, the middle three considerably larger than the others. Basal joint of labial palpi transverse. (Pronotum and the following tergites black) (*ex* Gardner) . . . . *Colfax* Andrewes ?

30. Anthiini.

Frontal piece not reaching hind margin of head, epicranial suture very distinct. Nasale produced and somewhat rounded, subtruncate, not toothed. Cervical groove and keel present. Antennae more or less distinctly shorter than mandibles; second and third joints entirely fused, appendix wanting. Mandibles with a smooth cutting edge and strong retinaculum, without a penicillus. Maxillae: stipes not much longer than wide, inner lobe absent, but the inner apex of the stipes produced into a long strongly-haired lobiform process, outer lobe two-jointed, the joints slender and cylindrical, the second shorter than the first, maxillary palpi stout, palpiger and first joint very short and transverse, second joint somewhat longer than wide, subcylindrical or slightly widened to apex, third joint cap-shaped, consisting of a short chitinous ring, which is hardly narrower than the second joint at apex, and a membranous coupole, which can be retracted (postmortal change ?); the last two joints sometimes of more normal shape on one side, probably as a result of regeneration. Labium rather hairy, produced into a conspicuous chitinous ligula, the two setae inserted on the dorsal surface of the latter and not very conspicuous. Two very unequal claws, one of them sometimes extremely small and inconspicuous. Tergites not margined, complete, ventral sclerites incomplete on first to seventh abdominal segments, interior postventrites broadly separated. Cerci stout, short, coniform, strongly pointed and setose, as is the entire body. Dorsum mainly black or piceous but one or more segments almost always pale reddish or yellow.

1 (4). Head, without mouth-parts, at least nine-tenths as long (including neck) on dorsal surface as wide (fig. 16). Cerci hardly wider at base than tenth segment or conspicuously shorter than head, and never more than twice as wide as tenth segment, strongly and rather evenly pointed in apical part, more or less shining (fig. 84). Adnasalia oblique, conspicuously produced above mandibles and more or less reaching level of nasale. If the epipleurites are bluntly coniform, the head is much longer than wide.

2 (3). Head almost as long as wide, rather strongly narrowed at neck (fig. 16). Adnasalia reaching level of nasale. Antennae almost as long as mandibles. Cerci as long as head or even longer, hardly wider at base than tenth segment (fig. 84). Epipleurites not coniform. Posterior claw of each tarsus more than half as long as anterior one. Ventral sclerites of eighth abdominal segment separated. Pronotum black . . . . *Eccoptoptera* Chaudoir ?

3 (2). Head longer than wide, very slightly narrowed at neck. Adnasalia not quite reaching level of nasale. Antennae much shorter than mandibles. Cerci shorter than dorsal surface of head, considerably wider at base than apex of tenth segment, and more or less distinctly wider than its base. Epipleurites not coniform (*gracilis hemiraphis* ?) or coniform (*caillaudi ukerewensis*) *Polyhirma* Chaudoir ?

4 (1). Head, without mouth-parts, much wider than long on dorsal surface, strongly narrowed at neck. Cerci more than twice as wide at base as tenth segment, longer than dorsal surface of head-capsule, usually suddenly constricted and pointed at apex. Adnasalia very broadly rounded exteriorly and usually much less prominent than nasale. Epipleurites coniform and strongly hirsute . . . . . *Anthia* Weber.

31. Brachinini.

Nasale without any teeth. Head without a distinct neck-part, cervical groove absent. Antennae not longer than mandibles, with few setae, third joint very large, much longer and thicker in first-stage larvae than the others. Cutting edge of mandible smooth, with at most a small retinaculum. Maxillae: inner lobe absent. Ligula and the pair of setae absent, first joint of labial palpi stout, the second longer than it. Claws neither toothed nor appendiculate. Tergites incomplete, not margined. Cerci absent or much shorter than the tenth segment, less than twice as long as wide. (Adult larvae are sometimes strongly adapted to sedentary half-parasitic life, some of the characters being then obliterated.)

1 (2). Two claws. Cerci absent. Mandibles without a retinaculum or a penicillus. Tenth abdominal segment not longer than the ninth, rather broad and segment-like. Second joint of the outer lobe slightly longer than first; second and third joints of maxillary palpi slender. A pair of anal tubes without crotchets, but with numerous tubercles. (First-stage larva—later stages unknown—with a single spiniform egg-burster (fig. 68) on hind end of frontal piece and with a pair of strong chitinous hooks on ventral hind end of sclerotised part of tenth abdominal segment.) . . . . . . *Pheropsophus* Solier.

2 (1). One claw. Cerci present. Mandibles with a small retinaculum (fig. 8) and a penicillus. Tenth abdominal segment tapering-cylindrical, hardly shorter than ninth, working as a pygopodium. Second joint of the outer lobe several times longer than the first (fig. 8); second and third joints of maxillary palpi rather stout, shorter than the first, the second hardly longer than wide. No distinct anal tubes. (First-stage larvae without egg-bursters, tenth abdominal segment without ventral hooks.) . . . . *Brachinus* Weber.

LIST OF MATERIAL AND LITERATURE STUDIED.

Abbreviations.

B.M. = British Museum (Natural History); coll. = collection (coll. E. = coll. van Emden); ded. = presented; det. = identified; educ. = bred; exuv. = exuvia; hw. = width of head in mm.; I. = adult; L = larva (I, II and III refer to the first, second and third instars respectively); leg. = collected; M.C. = Universitetets Zoologisk Museum, Copenhagen; M.P. = Muséum national d'Histoire naturelle, Paris, Laboratoire d'Entomologie; M.W. = U.S. National Museum, Washington; P. = pupa.

Where not expressly stated, it is not known definitely that a larva has been bred. The material marked "Verhoeff" has been purchased by the British Museum from Dr. K. W. Verhoeff, Pasing, nr. Munich, and with most of it no information other than the name of the species has been supplied. Much of this material was bred, and this may be regarded as practically certain, where several L I are concerned.—All the specimens in my own collection and in the available material of the Muséum d'Histoire naturelle, Paris, have been identified by myself, unless otherwise stated. With regard to the material in the British Museum, Universitetets Zoologisk Museum, Copenhagen, and United States National Museum, the information added to the material is cited, and deviations are marked "Emd. det." For the larvae collected by Father A. Conrads (in my coll.) credit should also be given to the Order of the White Fathers, to which Father Conrads belongs.

Cychrus caraboides L. 1 L II (hw. 1·81) Germany: Sächsische Schweiz, Kirnitzsch area, 30.x.21, K. Dorn leg. ded., coll. E. 318.—*C. attenuatus* Fabricius. 2 L II (hw. 1·43–1·79) C. Europe, Verhoeff, B.M.—1 L II (hw. 1·57) Germany: Glatzer Schneeberg, Seefelder, 3.xi.34, F. Pax leg., ded., coll. E. 1775. These larvae were not bred, but the less diverging cerci, shorter terminal joint of maxillary palpi, more pronounced and narrower dark median part of the tergites and the much finer, shallower and transversely rugose punctuation indicate that they must belong to the only other species occurring in the Sudeten Mountains. In most of these characters the larva differs from that described by Schiödte, whereas larva 318 fits the description of *rostratus* (= *caraboides*).

Scaphinotus (*Maronetus*) *debilis* Leconte ? 1 L III (hw. 1·84) U.S.A. : Round Knob (N.C.), 23.vi.93, under leaves on damp hill-side in ravine, coll. Hubbard 318, M.W. ; 1 L II (hw. 1·43) *ibid.*, vi.93, in damp wood under leaves, coll. Hubbard 317, M.W.—sp. ("*Nomaretus* ? "). 1 L (hw. 1·13) Linglestown (Pa.), 3.v.29, A. B. Champlain leg., M.W. Almost identical with the larvae of *M. debilis* : cerci slightly shorter, hind angles of ninth abdominal tergite less pointed; third antennal segment as long as fourth (slightly longer than fourth in *M. d.*), lateral parts of tergites less rugose; pronotum less transverse; size smaller.

Sphaeroderus stenostomus var. *lecontei* Dejean ? 1 L III (hw. 2·25) no locality, coll. Hamilton 580, M.W.

Ceroglossus suturalis Fabricius. 2 L III (hw. 2·62–2·72) Tierra del Fuego : Rio Grande, Estancia Viamonte, P. W. Reynolds leg., B.M. (fig. 72).—1 L III (hw. 2·69) Canal du Beagle, Mission du Cap Horn 1882–3, 323, M.P. See Lapouge, 1929, *Gen. Ins.* **192** : 59.—*gloriosus* Gerstäcker and *aeneovirescens* Faz, see Claude-Joseph, 1932, *Rev. chilen. Hist. nat.* **35** : 31.

Calosoma sycophanta L. 1 L III (hw. 3·48) Germany : Goseck, nr. Naumburg (Saale), 5.vii.25, H. Dietze leg., ded., coll. E. 1045.—*C. scrutator* F. 1 L II (hw. 3·1), 1 L III (hw. 4·2) U.S.A. : New Orleans, Sallé leg., B.M.—*C. inquisitor* L. 1 L III (hw. 2·86) Germany : Harth-wood, nr. Leipzig, 27.vi.15, on road, coll. E. 61 (figs. 29 and 75). See Cook, 1936, *Trans. Soc. Brit. Ent.* **3** : pl. 11.—*C. maderae rugosum* Degeer ? 2 L III dry (hw. 3·24–3·28) S. Africa, B.M.— ? 1 L III (hw. 3·19) E. Africa : Kilimanjaro, zone of plantations, Kilema, June, Ch. Alluaud leg., M.P.—*C.* sp. 1 L dry (hw. 2·86) Kenya : Lari, 15.vii–26.ix.99, C. S. Belton, B.M.—2 L (hw. 3·59 and 3·70) Kenya : Eldonyu eb Veru, Belton leg., B.M. (two species).—1 L (hw. 3·63) Algeria : El Golea, M.P.—1 L (hw. 3·24) Colonie du Cap : Steynsburg, 1909, F. Ellenberger, M.P.—1 L (hw. 3·17) Madagascar : Région de Sakarami, 1905, M. de Rothschild, M.P.—1 L dry (hw. 3·45) Monclova, Coahuila, Palmer leg., B.M.—1 L dry (hw. 3·21) Argentine : El Jabali, 4.i.31, J. B. Anderson leg., B.M.—1 L II (hw. 2·23). 6 L III (hw. 3·24–3·42–3·70) Persia, 20.vi.00, F. W. Townsend leg., B.M.—1 L (hw. 3·63) China : Nanking, 1908, G. de Joannis, M.P.—1 L (hw. 4·19) Australia, 12.v.24, prairie, G. H. Wilkins leg., B.M.—*C. beesoni* Andrewes, *himalayanum* Gestro, *indicum* Hope, *see* Gardner, 1927, *Ind. Forest Rec.* (*Ent.*) **13** : 63–65; 1929, *loc. cit.* **14** : 104–105. For the identification of other species *see* : Burgess and Collins, 1917, *Bull. U.S. Dept. Agric.* **417** : 18–20 and Lapouge, 1929, *Gen. Insect.* **192** : 44–60.

Carabus. A large mass of material of numerous species is to hand, but this would have to be the subject of a special paper, as the many subgenera created on adult characters are, so far, not in line with the sections formed from a study of larval characters (*see* Emden, 1936, *Ent. Blätt.* **32** : 16). The material is therefore not listed, but the head-widths of the British and non-alpine central European species and the number of each species measured are stated in the table of head-widths. The following recent papers will be found useful for identification : Bengtsson, 1927, *Lunds Univ. Årsskr.* (*N.F.*) (2) **24** (2) : 1–89. Lapouge, 1927, *C.r. Congr. Soc. sav. Paris* **1927** : 435–449, 6 pl.; 1929, *Gen. Insect.* **192** : 44–60. Raynaud, 1931–2, *Miscell. ent.* **33** : (3–8, 81–85), **34** : (28–29, 65–67); 1935, *Bull. Inst. Catal. Hist. nat.* **35** : 2–5.

Pelophila. No larvae are available. Except for the movable cerci of the full-grown larva the larvae described by Johnson and Carpenter have very little in common with those of the other Nebriini. The first stage is said to have fixed cerci, but no regard of this has been taken in the key, as it is almost certainly a faulty observation. The larva requires renewed study.

Eurynebria complanata L. 1 L II (hw. 2·62) France: Plage de Platz, 30.xii.04, Lapouge leg., det., B.M.—1 L III dry (hw. 3·28) N. Devon: Croyde, K. G. Blair leg., det., B.M.

Nebria (*Nebria s.str.*) *brevicollis* Fabricius.[33] 1 L I (hw. 0·84) Harpenden, Herts, Rothamsted Exp. Sta., K. D. Baweja, Emd. det. B.M.—1 L I (hw. 0·85) Windsor, 7.xi.35, H. Donisthorpe, B.M.—2 L III (hw. 1·71–1·81) Epping Forest, Essex, 14.iv., bred, K. G. Blair, B.M.—3 L III (2 dry, hw. 1·57–1·64–1·69) no locality, B.M.—2 L I (hw. 0·87) Germany: Leipzig, Burgaue, 25.x.23, K. Dorn leg., ded., coll. E. 1205.—1 L I (hw. 0·80) Schmiedeberg, Riesengebirge, Förster leg., Reichert det., ded., coll. E. 347.—1 L I (hw. 0·89) Leipzig-Connewitz, 2.x.19, in growing reed, coll. E. 235.—1 L II (hw. 1·22) Leipzig-Klein-Zschocher, 7.ii.32, on damp bank, O. Michalk leg., ded., coll. E. 914.—1 L II (hw. 1·24) Lindenthal, nr. Leipzig, 2.xi.30, O. Michalk leg., ded., coll. E. 889.—1 L II dry (hw. 1·15) Luckenwalde, Mark Brandenburg, 14.ii.28, Delahon leg., Korschefsky ded., coll. E.—1 L III (hw. 1·71) Naumburg, Saale, 25.iii.21, sifted, H. Maertens leg., ded., coll. E. 408.—2 L III (hw. 1·60–1·78) Denmark: Dyrehavn, nr. Copenhagen, 8.iv.28, E. Rosenberg leg., det., ded., coll. E. 769.—1 L III (hw. 1·71) C. Europe, Verhoeff, B.M.—1 L I (hw. 0·89) France: Compiègne, Oise, 6.ii.38, Colas leg., M.P.—1 L I (hw. 0·91), 1 L II (hw. 1·34) Marly, Seine-et-Oise, 20.xii.37, Levasseur leg., M.P.—? 1 L III (hw. 1·60) Switzerland: Davos, 1850 m., 11.ix., Verhoeff leg., B.M.—*N.* (*N.*) *hemprichi* Klug? 1 L III dry (hw. 2·13) Palestine: Jerusalem, 13.ii.29, Tarpukhi, Emd. det., B.M.—*N.* (*N.*) *andalusia* Rambur? 1 L III (hw. 1·74) Algeria: Bouzaréa, 20.ii.93, P. Lesne, M.P.—2 L I (hw. 0·84–0·87), 1 L II (hw. 1·19), 1 L III (hw. 1·78) Algeria: Ravin de la Femme Sauvage, nr. Algier, end of xii.92, P. Lesne leg., M.P.—1 L II (hw. 1·26) Algeria: Frais Vallon, env. d'Alger, fin xii.92, P. Lesne, M.P.—*N.* (*N.*) *rubicunda* Quensel? 1 L III (hw. 1·76) same data, i.92, M.P.—*N.* (*N.*) *cameroni* Andrewes. 1 L III (hw. 1·65) India: Dehra Dun, U.P., 30.i.30, in sand, J. C. M. Gardner leg., det., ded., B.M.—*N.* (*Paranebria*) *gyllenhali* Schönherr. 1 L I (hw. 0·94) Iceland: Gryla, 28.iv.29, under stones, R. Ph. Dollfus, M.P.—3 L III (hw. 1·53–1·63–1·73) Iceland, B. Samundner leg., B.M.—1 L III dry (hw. 1·67) Iceland: Reykjavik, 9.v.05, B. Samundner leg., B.M.—1 L I (hw. 0·91), 1 L II (hw. 1·15) Austria: Stubaier Alp, in soc. *N. gyllenhali* adults, H. Janetschek leg., B.M.—1 L III on slide (hw. 1·53) Palfneralpe, 2070 m., 17.ix.26, K. W. Verhoeff, B.M.—? 1 L III (hw. 1·67) Germany: Oberbayern, 1750 m., K. W. Verhoeff, B.M.—*N.* (*P.*) *livida* L.? 1 L I (hw. 0·98), 1 L III (hw. 2·06) Bucowina: Czernowitz, 7.vii.21, at bank of river, Netolitzky, coll. E. 665.—*N.* (*P.*) *jockischi* Sturm. 1 L I (hw. 1·15) Austria: Stubaier Alp, Alpein, in soc. *N. gyllenhali* and *jockischi* adults, H. Janetschek leg., B.M.—1 L I (hw. 1·15), 1 L III (hw. 2·06) Switzerland: Lower Wallis, lake Barberine, nr. Châtelard, 1900 m., Bänninger leg., ded., coll. E. 1977 (labelled *N. castanea* or *laticollis* by collector, but obviously more or less identical with 577).—*N.* (*P.*) *jockischi nigricornis* Villa. 1 L II? (hw. 1·74) Germany: Grosse Schneegrube, Riesengebirge, 3.vii.23, H. Dietze leg., ded., coll. E. 577.—*N.* (*P.*) sp. 1 L II? (hw. 1·36) France: Larrau, B. Pyr., xi.37. R. Paulian leg., M.P. Pronotum only slightly wider than long, paramedian teeth of clypeal horn very much longer than outer teeth.—*N.* (*Oreonebria*) *angusticollis* Bonelli ? 1 L II (hw. 0·98) Switzerland : Col de Fenêtre, Val Ferret, 1935, in soc. *N. angusticollis* and *castanea planiuscula* adults, M. Bänninger leg., ded., coll. E. 1975. This is a very isolated type, in which the pronotum is fully as long as wide, the head unusually rectangular and the outer teeth of the frontal horn very short, only slightly more projecting than the inner angles of the adnasalia, which are somewhat prominent.—*N.* (*Oreonebria*) *castanea* Bonelli ? 1 L II (hw. 1·08) Kandersteg, Balmhorn-hut, Gastern Valley, in soc. *Nebriola* sp. larva and *castanea*, *cordicollis escheri* Heer and *rhaetica* K. & J. Daniel, adults, Bänninger leg., ded., coll. E. 580.—*N.* sp. (characters of *Oreonebria*). 1 L III (hw. 1·88) China : Inkiaphou, S. Shensi, A. David, M.P.—*N.* (*Nebriola*) *fontinalis* K. & J. Daniel ? 1 L III ? (hw. 1·40) Bergamask Alps : Gerola alta, 2100 m., M. Bänninger leg., det., ded., coll. E. 795.—*N.* (*Nebriola*) *heeri* K. Daniel ? 1 L III (hw. 1·33) Calfeisen Valley, Sardona-hut, 2240 m., M. Bänninger leg., det., ded., coll. E. 1341 ; 1 L III (hw. 1·36) Maderau Valley, Brunni-glacier, 2150 m., in soc. *N. heeri* adults, M. Bänninger leg., det., ded., coll. E. 792.—*N.* (*Nebriola*) *cordicollis* Chaudoir. 1 L III (hw. 1·29) Wallis, Binnen Valley, M. Bänninger leg., det., ded., coll. E. 868.—*N.* (*Nebriola*) *cordicollis* var. ? 1 L III (hw. 1·40) Summit of Gemmipass, 1935, in soc. *cordicollis* var., (*Alpaeus*) *bremii* and (*Oreon.*) *castanea* adults, M. Bänninger leg., ded., coll. E. 1974.—*N.* (*Nebriola*) spp. 5 L III (hw. 1·22–1·28–1·34) Summit of Sussten-pass, 2200–2400 m., some in soc. *N. castanea* v. *brunnea* adults, M. Bänninger leg., ded., coll. E. 793, 797, 798.—1 L (hw. 1·19) Jura, Mt. Tendre, M. Bänninger leg., ded., coll. E. 801.—1 L III (hw. 1·40) Kien Valley, Gspaltenhorn-hut, 2380 m., M. Bänninger leg., ded., coll. E. 794.—*N.* (*Alpaeus*) *lafresnayei* Serville, *see* Raynaud, 1934, *Miscell. ent.* **35** (9) : (1–8) pl. 1 ; 1935, *loc. cit.* **36** (2) : 16.—*N.* (*Alpaeus*) *atlantica* Oberthur, *see* Paulian et Villiers, 1939, *Rev. franç. Ent.* **6** : 46, figs. 9–17. The drawings in both papers have obviously been made without a camera lucida, and the texts mainly report on generic characters, but from Paulian et Villiers' fig. 15 it would seem that the setae of the abdominal tergites are placed as in *Nebria s.str.* etc., and from Raynaud's fig. 2 (which otherwise is certainly not exact) the seta of the lateral parts of clypeus seems to be placed as in the same subgenera. Raynaud has counted six ocelli, Paulian et Villiers only five, and the latter statement seems to require confirmation. The prothorax of both species would appear to be similar to that of the species listed above as " *angusticollis* ? "

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[33] Some of these larvae may be expected to belong to *N. degenerata* Schaufuss, the adult of which is the same size and is extremely similar in appearance.

Leistus (*Pogonophorus*) *spinibarbis* Fabricius. 1 L II (hw. 1·22) Germany : Freiberg (Unstrut), Rödelplateau, 27.iii.35, O. Michalk leg., ded., coll. E. 1872 (figs. 3, 69.) Cerci with one seta more than in *Leistus s.str.*—*L.* (*Leistophorus*) *nitidus* Duftschmid, *see* Raynaud, 1937, *Misc. ent.* **38** : (64–66).—*L.* (*s.str.*) *ferrugineus* L. 1 L III (hw. 1·06, cerci 1·79) France : Versailles, 4.i.32, among grass-roots on marshy ground, L. Mesnil leg., ded., coll. E. 928.—1 L III (hw. 0·98, cerci broken) Germany : Harth-wood, nr. Leipzig, 22.ii.15, sifted from grass-roots, Martin leg., A. Reichert ded., coll. E. 13.—2 L III dry (hw. 1·05–1·08, cerci 1·64 and broken) Stanmore Common, 9.vi.(sic)34, K. G. Blair leg., B.M.—2 L II (hw. 0·83–0·88, cerci 1·45) France : Marly (Seine), 26.xii.37, dried-out pool, L. Levasseur leg., M.P.—1 L III (hw. 1·05, cerci 1·74) Forêt de Marly, 23.i.38, between roots of *Scirpus* at the border of a marsh, R. Paulian leg., M.P.—(?) 1 L II (hw. 0·84, cerci 1·36) Harpenden, Herts, Rothamst. Exp. Sta., K. D. Baweja, B.M.—*L.* (*s.str.*) *terminatus* Hellwig (*rufescens* auct.) ? 1 L III (hw. 1·05, cerci 1·57) France : Versailles, 4.i.32, among grass-roots on marshy ground, L. Mesnil leg., ded., coll. E. 928.—1 L III (hw. 1·05, cerci

1·47), 1 P. C. Europe, Verhoeff, B.M. (labelled "*Leistus ferrugineus*", but fitting Schiödte's description of *L. rufescens*).—*L.* (*s.str.*) *terminatus* Hellwig (*rufescens* auct.). 3 L I (hw. 0·61–0·63–0·66, cerci 1·12–1·15) Germany: Schkeuditz, nr. Leipzig, 5.x.18, sifted on marshy ground, coll. E. 171.—1 L II (hw. 0·80, cerci 1·29) Lindenthal, nr. Leipzig, 2.xi.30, O. Michalk leg., ded., coll. E. 890.—14 L III (hw. 0·92–1·00–1·05, cerci 1·40–1·51–1·64) various places nr. Leipzig: Bistum, 26.xii.35, on snow, O. Michalk leg., ded., coll. E. 2516; Grossstädteln, 11.ii.34, under bark, O. Michalk leg., ded., coll. E. 1138; Schönau, 17.i.32, 12.iii.32, sand-pit, O. Michalk leg., ded., coll. E. 917, 1024; Kohren, Stöckigt-wood, 5.i.31, sifted, O. Michalk leg., ded., coll. E. 922; Klein-Zschocher, 7.ii.32, sifted, O. Michalk leg., ded., coll. E. 915; Portitz, 27.xii.31, sifted at ditch, O. Michalk leg., ded., coll. E. 913; Connewitzer Holz, 5.iii.22, in rotten tree-stump, A. Schulze leg., ded., coll. E. 460.—1 L III (hw. 1·01, cerci 1·47) Beimoor-wood, nr. Hamburg, from *Alnus*-stump, K. Sokolowski leg., Emd. det., Mus. Hamburg ded., coll. E. 1170.

Notiophilus biguttatus Fabricius. 1 exuv. III, 1 L III (hw. 0·87, cerci 1·29), 1 I. Denmark: Dyrehavn, nr. Copenhagen, 24.viii.02 (pupated 28.viii.), W. Schlick leg., det., E. Rosenberg ded., coll. E. 933.—I L III dry (hw. 0·84, cerci missing) Iceland, B.M. (mentioned as *Stenus* sp.? by Mason, 1890, *Ent. mon. Mag.* **26**: 199).—4 L I (hw. 0·48–0·49–0·50, cerci 0·65), 2 L II (hw. 0·56–0·59–0·61, cerci 0·87–0·88–0·91), 1 L III (hw.?, cerci 1·19) Germany: Doberschütz, nr. Eilenburg, 3.vi.23, K. Dorn leg., ded., coll. E. 1204, 1207 (fig. 4).—3 L III (hw. 0·84, cerci 1·22) S. Kensington, viii.34, S. J. Turpin leg., B.M.—1 L II (hw. 0·50, cerci 0·87), 2 L III (hw. 0·79–0·84, cerci 1·29) Boxhill, Surrey, v.32, K. G. Blair, B.M.—1 L I on slide (hw. 0·50, cerci 0·77) C. Europe, iv.22, among decaying needles of spruce, Verhoeff, Emd. det., B.M. (labelled *Leistus spinibarbis*).—1 L III on slide (hw. 0·87, cerci 1·08) Pasing, nr. Munich, 15.v.23, on field, K. W. Verhoeff leg., B.M.—1 L III (hw. 0·85, cerci broken) C. Europe, Verhoeff, Emd. det., B.M., labelled "*Leistus spinibarbis*".—*N. aquaticus* L.? 1 L I (hw. 0·56, cerci 1·05) Bexhill, Sussex, v.32, K. G. Blair leg., B.M. (apical two-fifths of cerci whitish, abdominal tergites brown).—*N.* sp. 1 L III? (hw. 0·70, cerci 1·08) Kingsbury, London, 21.vi.34, S. J. Turpin leg., B.M. (head and tergites almost entirely testaceous, cerci brown with short whitish tips, perhaps *rufipes* Curt.?).—*N.* sp. 1 L II (hw. 0·66) Croyde, N. Devon, iv.28, K. G. Blair leg., B.M.

Pachyteles? sp. 1 L (hw. 1·61) Guatemala: Primavera, 4.i.39, log, under bark, M.W. The larva is just less than 10 mm. long and not quite 2 mm. wide. Full-grown larvae of some of the species should be even smaller, some others considerably longer. This is certainly another genus than the larvae described as *Physea setosa*.

Physea setosa Chaudoir, *see* Emden, 1936, *Arb. phys. angew. Ent.* **3**: 250–256.

Omophron limbatum Fabricius. 1 L I on slide (hw. *c.* 0·52) raised from adults collected at Lindenthal, nr. Leipzig, vi–vii., coll. E. 145.—1 L III (hw. 1·08) Denmark: Fürsö, 19.viii.94, in sand, K. W. Schlick leg., det., Rosenberg ded., coll. E. 186.—*O. rothschildi* Alluaud? 1 L II (hw. 0·87), 4 L III (hw. 1·26–1·30–1·34) Lake Rudolph, central island, M. de Rothschild, M.P.—*O. tessellatum* Say and *americanum* Dejean, *see* Silvey, 1936, *Pap. Michigan Acad. Sci.* **21**: 687.—*O. smaragdus* Andrewes, *see* Gardner, 1938, *Indian Forest Rec.*, (n.s.) (*Ent.*) **3**: 149.

Loricera pilicornis F. 1 L III (hw. 1·12) Hertfordshire, 21.vi.29, G. V. Wick leg., B.M.—1 L III (hw. 1·08) C. Europe, 20.vi., Verhoeff, B.M.—2 L II (hw. 0·73–0·77), 1 L III (hw. 1·08) Denmark: Dyrehavn, nr. Copenhagen, 28.vii.06,

E. Rosenberg leg., det., ded., coll. E. 187.—1 L III (hw. 1·08) Germany: Schkeuditz, nr. Leipzig, 27.vi.18, sifted from decaying leaves, coll. E. 102; 2 L III dry, 1 L III on slide (hw. 1·08–1·11–1·15), same data, 13.vii.18, coll. E.

Elaphrus riparius L. 2 L, 1 exuv. III (hw. 1·04–1·06–1·08) Burgh, vi.41, K. G. Blair leg., B.M.—1 L II (hw. 0·68), 2 L III (hw. 0·99–1·01) Bookham, Surrey, 23.viii.32, K. G. Blair, B.M.—? 1 L I (hw. 0·49), 1 L II (hw. 0·71) Germany: Tolkemit, Frisches Haff, E. Prussia, 7.vii.37, in sand of beach, Otten leg., Korschefsky ded., coll. E. 2877.—*E. cupreus* Duftschmid. 1 L III (hw. 1·05) Germany: Stotternheim, nr. Erfurt, 18.vii.24, K. Dorn leg., ded., coll. E. 2506 (fig. 73).—1 L III dry (hw. 1·15) Schkeuditz, nr. Leipzig, 13.vii.18, sifted from decaying leaves, coll. E., pres. to B.M.—1 L III (hw. 1·15) Dübener Heide, nr. Leipzig, 5.viii.23, in detritus at bank of pool in wood, H. Dietze leg., ded., coll. E. 2399.—*E. aureus* Müller, *see* Raynaud, 1937, *Misc. ent.* **38**: (61–64).

Blethisa multipunctata L. 1 L III (hw. 1·53) Denmark: Damhussöen, 15.vii.10, under stone, Schlick leg., M.C. (fig. 74).

Pasimachus spp. 1 L (hw. 4·13) Mexico: Toluca, Mex., M.W.—1 L (hw. 4·65) U.S.A.: Retreat, N.C., under stone in meadow, 17.vi.93, coll. Hubbard 304, M.W.—1 L, died in pupating (hw. 4·0) Eureka, Ill., M.W.—1 L (hw. 4·7) Texas, B.M.

Gen. indet. 1 L II or III (hw. 3·0) Uganda: Mt. Elgon, 10,000 ft., iii.34, bamboo zone, H. B. Johnston, B.M. The larva is amazingly closely related to *Pasimachus*, but the locality cannot be doubted. All the species known from Mt. Elgon belong to *Scarites*, *S. elgonensis* Bänninger being particularly numerous (Bänninger, 1935, *Miss. sci. Omo* **2** (4): 91–99).

Storthodontus coquereli amplipennis Bänninger. 1 L I (hw. 3·9), 1 L I pale, 2 eggs Madagascar: Island Bérafia, Dist. Nossibé, M. Bänninger det., ded., coll. E. 1874.

Dyscherus praelongus Fairmaire? 1 L II? (hw. 4·4) Madagascar 79·19, B.M. The larva was acquired together with an adult of *D. praelongus* and was labelled thus by Dr. Blair; its characters seem to confirm this association.—*D.* sp. 1 L III (hw. 6·0) Madagascar: Paya Mahafaly, Bastard leg., M.P.

Scarites (*Distichus*?) sp. 1 L (hw. 2·66) Costa Rica: Reventazon, Hamburg Farm, 30.iv.32, under loose bark, F. Nevermann, coll. 2973. This specimen was found associated with adults of *Morio georgiae* Palisot, and was at first regarded as that species. There are, however, too many deviations from typical Pterostichini (absence of antennal appendage, of mandibular penicillus, immarginate, complete abdominal tergites, slightly unequal claws). I think this is most probably the larva of a *Distichus* in spite of the rather abnormal find under loose bark, which may, however, have been that of a tree lying on the ground.—*S.* (*Distichus*?) spp. 4 L III (hw. 2·56—2·58—2·60) Tonkin: upper region of river Claire, spring–summer, A. Weiss leg., M.P.—1 L III (hw. 2·34) Ivory Coast: San Pedro, Thoiré leg., M.P.—*S.* (*Scaritodes*) *semicarinatus* Chaudoir. 1 L II (hw. 2·48) Brazil: Mendés, Rio de Janeiro, 25.ix.33, in nest of *Atta sexdens* L., H. Eidmann leg. in soc. imag., ded., coll. E. 2442 (fig. 9).—*S.* (*Scarites* pars a) *cyclops* Crotch? (or *buparius* Forster, adult 23–38 mm.). 1 L III (hw. 6·3) Tangier, G. Buchet leg., M.P.—*S.* (*Scarites* pars b) *sulcatus* Olivier. 1 L II (hw. 4·2), 2 L III (hw. 5·4–6·2) Burma: Sahmaw, 4.iii.34, B.M.—*S.* (*S.*) *subterraneus quadriceps* Chaudoir. 3 L II? (hw. 2·30–2·39–2·44) U.S.A.: Milwaukee, Wisc., 14–22.viii.37, Harry van Emden leg., ded., coll. E. 2975, 2976, 2979 (fig. 51). *S. subterraneus quadriceps* is the only species of *Scarites* collected by my brother, and the adult was very common at the places where the larvae were found.—*S.* (*S.*) *abbreviatus* Dejean. 1 L III (hw. 3·24) Madeira, v–vi.96, in dead laurel-tree, A. Fauvel leg., M.P.—*S.* (*S.*) *tenebricosus molossulus* Bänninger ? 2 L I (hw. 2·58–2·69), 2 L III (hw. 4·5–4·7) E. Africa : Ukerewe Island, Lake Victoria, A. Conrads leg., ded., coll. E. 2926. *S. senegalensis simogonus* Chaudoir (adult 19–28 mm.) has also been collected by Father Conrads, but is obviously too small for these larvae.—*S.* (*S.*) *indus* Olivier, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2** : 190.—*S.* (*S.*) spp. 1 L (hw. 2·16) Persia : Susé, de Morgan leg., M.P.—1 L (hw. 2·09) France : Pondichéry, viii.01, M. Maindron leg., M.P.—1 L (hw. 3·14) Morocco : nr. Tangier, G. Buchet leg., M.P.—1 L (hw. 4·1) Morocco : Oglat el Rachid, Sedillot leg., M.P.—1 L (hw. 2·90) Argentina : Gran Chaco, banks of Rio Tapenaga, nr. Colonia Florencia, E. R. Wagner leg., M.P.—1 L (hw. 2·44) Argentina : Buenos Aires, Rafinesque leg., M.P.

Clivina fossor L. 1 L III (hw. 0·84) Denmark : Ellistöd, Lolland, v., M.C.

Dyschirius arenosus Steph. 1 L II ? (hw. 0·45) Corton, Suffolk, ix.26, K. G. Blair leg., B.M.

Trechini : The literature is cited by Boldori, 1932, *Mem. Soc. ent. ital.* **10** : 149–167. The few papers which have appeared since are : 4 by Boldori (cited in the last of them 1936, *Le Grotte d'Italia* (2) **1** : 93 note), one each by Gardner (1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2** : 184, *Trechus indicus* Putzeys), Womersley (see *Amblystogenium*), Strouhal (1938, *Mitt. Höhlen-Karstforsch.* **1938** : 105, *Anophthalmus mariae* Schatzmeyer), and Bolivar (see *Trechus*). Very few larvae of this group being at hand, the characters of the genera have mainly been taken from the literature.

Perileptus areolatus Creutzer ? 1 L I on slide, no egg-bursters (hw. 0·26) Italy : Sabbio Chiese, prov. Brescia, 21.vii.35, at bank of mountain-stream, L. Boldori leg., det., ded., coll. E. See Boldori 1936, *Studi Trentini Sci. nat.* **17** (1) : (7 pp.).—1 L II ? on slide (hw. 0·38) no locality, coll. E.

Aepopsis robini Laboulbène. 2 L III (hw. 0·40–0·42) France : Ile d'Yeu, Vendée, vii–viii.37, in cracks of rocks, R. Paulian leg., det., M.P. ded., B.M.

Temnostega antarctica Enderlein and *Amblystogenium pacificum* Putzeys. Only a head of the larva of each of these species was known to Enderlein (1909, *in* Drygalski, *Deuts. Südpolar-Exp., Zool.* **2** : 372, 374), and Jeannel and Boldori rely on his descriptions. The characters of the cerci and tarsi etc. are, therefore, hypothetic, as far as *Temnostega* is concerned. Full-grown entire larvae of *Amblystogenium* have since been obtained and described by Womersley (1936, *B.A.N.Z. Antarctic Res. Exp. Rep.* (B) **4** (1) : 25). Although no details of the mouth-parts are given, the legs are said to end in two slightly unequal claws, and the fourth antennal (*sic*) joint to be subdivided by a distinct suture.

Typhlotrechus bilimeki hauckei Ganglbauer. 1 L II on slide (hw. 0·98) Yugoslavia : Ciganska jama, 22.ix.29, E. Pretner leg., L. Boldori ded., M.W.—*T. b. hacqueti* Sturm. 1 L III (hw. 1·05) Ljubljana, S.H.S., Velika Pasjica, near Gorenji, 25.ii.34, Pretner leg., Boldori det., coll. E. 1920.

Speotrechus humeralis Dodero. 1 L on slide (hw. 0·68) Italy : Buco del frate, 9.ii.36, L. Boldori leg., det., ded., coll. E.—1 L on slide (hw. 0·80) Italy : Buco del frate, 1.iii.31, L. Boldori leg., det., ded., M.W.

Trechus pulchellus Putzeys ? 1 L II (hw. 0·31) Germany : Glatzer Schneeberg, 23.vii.35, subalpine spring, F. Pax leg., ded., coll. E. 2435. Extremely similar : *Paratrechus sylvaticus* C. Bolivar, *see* Bolivar Pieltain, 1941, *Ciencia, Mexico* **2** : 208.

Asaphidion flavipes L. 1 L III (hw. 0·84) Denmark : Ravneholm, 17.v.17, E. Rosenberg leg., det., ded., coll. E. 188.—1 L I on slide (hw. 0·39) viii.38, L. Boldori educ., ded., coll. E. Boldori (1939, *Boll. Soc. ent. ital.* **71** : 98)

stresses certain differences between the larvae described by Böving and his own larvae of *A. flavipes* and points out that the pupa, obtained from a larva collected under the same conditions as Böving's specimen (though not necessarily originating from the same parents, *see* Rosenberg, 1911, *Ent. Meddel.* (2) **4** : 182), belongs to *A. pallipes* Duftschmid. The differences between Böving's and Boldori's larvae are, however, perhaps more those of stages than of species. Böving described a full-grown larva, whereas Boldori obtained only the first stage of *flavipes.* The dilated setae, described by Boldori, are very often a special character of this stage in beetle-larvae. The neck in Böving's figure, referred to by Boldori, is produced by the cervical groove, which in Bembidiini is developed as an impression, connected by a transverse dorsal groove with that of the other side. It is present in my L III, though not quite as striking as in Böving's figure. Of *A. caraboides* Schrank, Boldori described mainly the first stage; it is distinguishable by the cerci.

Bembidion (*Daniela*) *fasciolatum* Duftschmid. 4 L I (hw. 0·40–0·42), 1 L II (hw. 0·63) Netolitzky educ., ded., coll. E.—*B.* (*Peryphus*) *testaceum* Duftschmid. 2 L I (hw. 0·35) Bucowina : Czernowitz, 29.vi.27, Netolitzky educ., ded., coll. E (fig. 24).—*B.* (*P.*) *dalmatinum* Dejean. 2 L I on slide (hw. 0·40–0·41) Netolitzky educ., ded., coll. E.—*B.* (*P.*) *femoratum* Sturm? 3 L I (hw. 0·45–0·48–0·49), 1 L II (hw. 0·61) on slides, Netolitzky educ., ded., coll. E. The larvae seem to belong to a larger species of *c.* 6·5 mm., and according to Prof. Netolitzky his culture of *B. femoratum* was mixed with another species while he was absent.—A good figure of the front margin of frontal piece, apparently of first-stage larvae, was given by Netolitzky (1926, *Ent. Blätt.* **22** : 118) for the following species : *semipunctatum* Donovan, *starki* Schaum, *femoratum* Sturm, *fasciolatum* Duftschmid, *genei illigeri* Netolitzky, *biguttatum* L. and *dalmatinum* Dejean.—*B.* (*Cillenus*) *laterale* Samouelle. 2 L (hw. 0·70) Denmark : Skallingen, vii.97, Jensen-Haarup leg., M.C. *Cillenus* is now generally regarded as one of the numerous subgenera of *Bembidion*, and the larvae seem to justify this view; they are characterised by subequal joints of the outer lobe (the apical joint inconspicuously shorter), the nasale rather strongly produced and truncate, with the front margin almost straight, minutely denticulate and angularly set off from adnasalia, and the long epicranial suture which is as long as the first antennal joint and the front margin of nasale.—*B.* spp. 6 L III, 2 on slide (hw. 0·89–0·95–1·01) Germany : Zeyern, viii.21, K. Dorn leg., ded., coll. E. 252.—1 L (hw. 0·73) Büsum, North-Sea, vi.21, C. Urban leg., ded., coll. E. 249.—1 L (hw. 0·84) Switzerland : San Bernardino, village, *c.* 2000 m., 17.viii.24, M. Bänninger leg., ded., coll. E. 583.—3 L (hw. 0·98–1·02–1·05) Austria : Paalgraben, Styria, 20.vii.30, Netolitzky leg., ded., coll. E. 872.—1 L (hw. 0·42), 1 L (hw. 0·54), 8 L (hw. 0·87–0·98) Waidhofen on Ybbs, 15.viii–15.ix.20, Netolitzky leg., ded., coll. E. (probably several species).—3 L (hw. 0·77–0·81–0·84) Stubaier Alp, in soc. *B. bipunctatum* v. *nivale* Heer and *B. redtenbacheri* Daniel, H. Janetschek leg., B.M.—1 L (hw. 1·03) Bucowina : Czernowitz, 7.vii.21, banks of Pruth, Netolitzky leg., ded., coll. E. 667.—1 L (hw. 0·98) same data, 25.v., coll. E.—1 L (hw. 0·96) same data, 16.v.26, coll. E.—2 L (hw. 0·49), 1 L (hw. 0·77) same data, 27.v.21, coll. E.—1 L (hw. 0·91) Cooden Beach, Sussex, 19.vii.36, W. S. Bristowe leg., B.M.—1 L (hw. 1·01) Aviemore, vi–vii.34, K. G. Blair leg., B.M.—1 L (hw. 0·52) France : Ile d'Yeu, Vendée, 2.viii.37, bord d'une mare, R. Paulian leg., M.P.—3 L (hw. 0·75–0·77–0·80) Spain : Sierra Nevada, 3100 m., petite lagune au pied du Mulhacer, 5.viii.34, A. Balachovsky leg., M.P.—1 L (hw. 0·92) Morocco : High Atlas, Inri n'Ouaba, 2000 m., 9.ix.38, Paulian et Villiers leg., M.P.—1 L (hw. 0·87) Morocco : O. Tnuinène, viii.38, Paulian et Villiers leg., M.P.

Bembidion sp.? or genus indet. 2. 1 L (hw. 1·01) Sudan: Khartoum, Ch. Alluaud leg., M.P. The nasale is bidentate with the outer margin of the teeth parallel to the longitudinal axis of the body and the inner margin oblique-concave: it may also be described as broadly produced with parallel side-margins and broadly and rather strongly emarginate front margin. This formation has not otherwise been seen in this group, and the larva may, therefore, not belong to it. The second joint of the outer lobe is distinctly shorter than the first. The first antennal joint is slightly longer than the second and third, the first joint of the maxillary palpi longer than the other two combined. The abdominal tergites are not sclerotised, their setae are numerous, short, but strong, rather blunt, some of them obliquely directed forward. Epicranial suture short, other characters as in *Bembidion* and *Asaphidion.* This must be either a very isolated form of *Bembidion* or the representative of a special tribe, perhaps *Melaenus,* which may be supposed to have more or less similar characters.

Tachys (*Mioptachys*?) sp. 1 L I (hw. 0·22), 1 L III (hw. 0·38) Costa Rica: Reventazon, Hamburg Farm, 10.ii.34, soil of wood, F. Nevermann leg., ded., coll. E. 1671.—*T.* (*Tachyta*) *nanus* Gyllenhal. 1 L III on slide (hw. 0·54) Germany: Ganting, 29.vii.22, on *Carpinus*, K. W. Verhoeff leg., B.M (figs. 26, 44). *Tachyta* is now regarded as a subgenus of *Tachys.*—*T.* (*Tachyta*) *umbrosus* Motschulsky, *see* Gardner, 1938, *Indian Forest Rec.* (n.s.) (*Ent.*) **3** : 152.—*T.* (*T.*) sp. 1 L I (hw. 0·26) Costa Rica: Reventazon, Hamburg Farm, 6.vii.34, under loose bark of *Virola warburgi*, F. Nevermann leg., ded., coll. E. 1594.—*T.* (*Tachyura*) *vivax* Leconte. 1 exuv. III (hw. 0·43), 1 I. no locality, coll. Hamilton 462, M.W.—*T.* (*T.*) *incurvus* Say. 1 exuv. III (hw. 0·41), 1 I. no locality, coll. Hamilton 472, M.W.—*T.* (*T.*?) sp. 1 L III (hw. 0·56) France: Bormeo, Var, iii.37, R. Paulian leg., M.P. In this species the second joint of the outer lobe is hardly 1½ times as long as the first. The other characters are as in the preceding two species.—*T.* (*T.*) *parvulus* Dejean, *see* Cerruti, 1939, *Mem. Soc. ent. ital.* **17** : 121.

Pogonus luridipennis Germar? 5 L II, 1 L II dry (hw. 0·94–1·02–1·08), 2 L III (hw. 1·40–1·50) Germany: Sülldorf, nr. Magdeburg, viii.21, on bank of salt-spring, C. Urban leg., ded., coll. E. 661 (det. ex syst., et magnitudine, figs. 6, 27). 1 L III (hw. 1·43) France: Château-neuf d'Ille-et-Vilaine, under decaying leaves, K. Dorn leg., ded., coll. E. 240.—*P.* spp. 1 L (hw. 1·19) Braunton, N. Devon, ix.29, K. G. Blair leg., Emd. det., B.M.—1 L (hw. 0·84) France: Chausey, Schanedes, 29.vii.36, île aux oiseaux, H. Bertrand leg., M.P.

Broscus cephalotes L. 3 L I (hw. 1·93–1·96–1·99) Braunton, N. Devon, ix.29, K. G. Blair leg., B.M.—1 L I (hw. 1·99) Central Europe, Verhoeff, B.M.—1 L I (hw. 1·93), 1 L II (hw. 2·81) Heligoland: Düne, 22.viii.28, H. Dietze leg., ex coll. E., B.M.—2 L II (hw. 2·65) Germany: Gossa, nr. Leipzig, 1.x.24, in sand, K. Dorn leg., ded., coll. E. 1067.—1 L II (hw. 2·69) Böhlen, nr. Leipzig, 3.x.14, at recently killed hamster, coll. E. 1.—1 L II (hw. 2·58) Taucha, nr. Leipzig, 19.ix.21, in sand-pit under stone, F. Halbauer leg., ded., coll. E. 431.—1 L III (hw. 3·7) Riesa on Elbe, 2.v.35, in garden-soil, W. Döhler leg., ded., coll. E. 2161.—3 L I (hw. 1·92–1·98–2·02) Heligoland, Düne and Harbour, 22.viii–28.viii.35, H. Dietze leg., ded., coll. E. 2385.—1 L I (hw. 1·92) Zeyern, *c.* 15.viii.21, K. Dorn leg., ded., coll. E. 350.—1 L I (hw. 1·92) Nürnberg-Ziegelsteine, 28.viii.19 in soc. *Harpalus rufus* Brüggemann Stich leg., ded., coll. E. 194.—1 L I (hw. 1·85), 1 L II (hw. 2·50), 5 L III (hw. 3·6–3·68–3·8) Zibelle-Beinsdorf, nr. Rothenburg, Oberlausitz, 20–25.x.17, in soil of potato-field, coll. E. 117.—3 L I (hw. 1·74–1·84–1·92), 3 L II (hw. 2·55–2·68–2·83) Numburg, nr. Kelbra, 29.ix.35, on salty soil, H. Dietze leg., ded., coll. E. 2386.—*B.*

punctatus Dejean, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) *Ent.* **2** : 181, 185.—*B.* sp. 1 L II (hw. 2·44) Algeria : Ravine de la Femme Sauvage, nr. Alger, end of xii.92, P. Lesne leg., M.P.

Axonya championi Andrewes. 1 L III (hw. 1·47), 1 I. India, J. C. M. Gardner leg., det., ded., coll. E. 2360.—1 dissected exuv. III on slide (hw. *c.* 1·47) India : Asan R., 8.iv.30, J. C. M. Gardner leg., det., ded., coll. E. *See* Gardner, 1931, *Indian Forest Rec.* (*Ent.*) **16** : 92; 1936, *loc. cit.* (n.s.) **2** : 182.

Cnemacanthus desmaresti darwini Waterhouse ? Dr. Carlos Bruch has sent me, together with the drawings reproduced as figs. 90–97, a very curious larva from the Pampas of the Argentine (hw. 5·1). Dr. Bruch obtained specimens of this larva repeatedly, but has been unable to breed the adult. From the present keys it would be identified as Brachynini, but the setae of the ligula (not, however, the ligula itself) seem to be present. The two claws would fit *Pheropsophus,* whereas the presence of cerci, a retinaculum etc. would exclude it from that genus. The larva is 28 mm. long though moderately contracted, and in combination with its rather stout build, would seem to be too large for the species of *Pheropsophus* occurring in Argentine. There is no other genus of known Argentinian Truncatipennes, with which its habitat, size and characters would agree, and Dr. Bruch may be right in referring it to *Cnemacanthus desmaresti darwini* Waterhouse, though all the important characters of Broscini are absent. However, the adult Broscini as a whole are most inconsistent in their characters, and I have discovered that in *Cnemacanthus* and its relatives even the paramera are as in Pterostichini. As the mandibular seta is also absent and in some species two (1 + 1 or 0 + 2) or three (1 + 2) supraorbital setae are present, *Cnemacanthus* approaches the Pterostichini very closely. In the present larva not too much weight should perhaps be laid on the reduction of the cerci, though this brings it into the truncatipenne series in the key. For the cerci are very liable to reduction and are by no means an ideal character for separating the truncatipenne and piliferous HARPALINAE. Even so, however, the larva shows no clear affinities to the Broscini, Pterostichini or any other group.

Deltomerus corax Peyerimhoff. 1 L II (hw. 1·2), 2 L III (hw. 1·88–2·18) Morocco : Haut Atlas, Tizi n'Tachdirt, 3200 m., 20.vi.38, R. Paulian and A. Villiers leg., det., M.P. *See* Paulian & Villiers, 1939, *Rev. franç. Ent.* **6** : 48; the locality given in the description differs from that in the tube.

Diplous aterrimus Dejean. 1 exuv. III (hw. 1·8), 1 I. U.S.A. : Yellowstone National Park, pupa and larval exuvia found in mud-cell under a boulder, resting on a flat rock in bed of stream, at low water, 12.viii.91, Hubbard leg., M.W.

Abacetus pars a. Two slides (J.C.M.G. 3101 and 3102), borrowed from Mr. Gardner some time ago, contain exuviae, from both of which *Abacetus guttula* Chaudoir was bred according to the labels. In one specimen only one claw is present, whereas in the other a conspicuous second claw, two-fifths the length of the main claw, is to be seen. In the first specimen the emargination of the nasale is narrower and deeper. As far as my experience goes, these cannot be one species and probably not closely related species, and Mr. Gardner has, therefore, not published a description of the larva of *Abacetus guttula,* though both specimens were hatched singly. Mr. H. E. Andrewes informs me that *guttula* is quite a typical *Abacetus* but rather variable. The genus *Abacetus* is perhaps not homogenous, for the only other species bred by Mr. Gardner, *A. iricolor* Andrewes, shows larval characters which are rather different and which would include it in the Pterostichina. According to Mr. Andrewes *iricolor* is " hardly a typical species of *Abacetus.*"

Caelostomus picipes McLeay. 1 L II on slide (hw. 0·75) J. C. M. Gardner leg., det. " by comparison," ded., in B.M. *See* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2** : 191.

Diceromerus orientalis Hope. 1 L III (hw. 1·8) J. C. M. Gardner leg., det., ded., B.M. I have some drawings which I have made from a specimen preserved in the Forest Research Institute, Dehra Dun, and labelled Samsnig, Bengal, Balmand Singh leg., Nr. 1754, S 1515. The characters are identical. *See* Gardner, 1929, *Indian Forest Rec.* (*Ent.*) **14** : 107.

Cratocerus sulcatus Chaudoir? 1 L II? (hw. 0·59) Costa Rica : Reventazon, Hamburg Farm, 27.vii.34, on rotting stump of banana-tree, F. Nevermann leg., ded., coll. E. 1543. Very closely related to the *Caelostomus*-larva; *Cratocerus* is the genus nearest to the Drimostomina in Costa Rica, though not actually belonging to the subtribe.

Sphodrus leucophthalmus L. 1 L I on slide (hw. 1·26) Italy : Cremona, 3.v.33, L. Boldori educ., ded., coll. E. *See* Boldori, 1934, *Boll. Soc. ent. ital.* **66** : 102.—1 L III (hw. 3·53) Italy : Roma, Schiödte, M.C., Emd. det. labelled "*Acinopus*", but certainly not belonging to the Harpalini. Nasale truncate, but obviously worn.—1 L III (hw. 3·23) Morocco : Agadir, ii.14, P. Pallary leg., M.P. Nasale straight in middle, with two very slight broad prominences on either side.

Pristonychus terricola Herbst. 2 L III (hw. 1·88–2·01) Germany: Göda, nr. Bautzen, Saxony, 1934, Feurich leg., ded., coll. E. 1458.—2 L III (hw. 2·06–2·19) France : Bougival, xii.29, in mushroom-cultures, L. Mesnil leg., ded., coll. E. and B.M.—1 L III (hw. 2·03) East Prussia, iii.33, in cellar with potatoes, H. Blunck leg., coll. E. 1097.—1 L III (hw. 2·06) Leipzig, Connewitzer Holz, 10.iii.12, A. Reichert leg., det., ded., coll. E. 179.—1 L II (hw. 1·37) 16.v.18, 1 L III (hw. 2·03) 5.vi.18, Denmark : Holte, Sjaelland, I. P. Kryger leg., M.W. *See* Boldori 1934, *Boll. Soc. ent. ital.* **66** : 109.

Laemostenus (s.str.) *complanatus* Dejean. 1 L II (hw. 1·39), 1 exuv. III (hw. 2·14) U.S.A. : San Francisco, Calif., 22.ii.34, P. Ting leg., Van Dyke det. adult, M.W.—*L.* (*Antisphodrus*) *schreibersi carinthiacus* Müller. 1 L I (hw. 0·83) 1 L II (hw. 1·27) Austria : Warmbad Villach, Eggerloch, 20.ix.33, H. Strouhal leg., det., ded., coll. E. 1398; 3 L I (hw. 0·79–0·83–0·86) same data, *c.* 180 m., 11.ix.33, coll. E. 1400; 1 L III (hw. 1·89) same data, 5.ix.33, in rotten faeces, coll. E. 1399. *See* Strouhal, 1934, *Mitt. Höhlen-Karstforsch.* **1934** : 80; 1935, *loc. cit.* **1935** : 34.—*L.* (*A.*) *boldorii* Dodero. 1 L I (hw. 0·84) Italy : Nuvolento, Buco del Frate, 21.xii.30, C. Boldori leg., M.W.—3 L III (hw. 1·69–1·85–1·95) Italy : Paitone, Brescia, Lombardia, grotta Bug del Frat, 18.xi.24, L. Boldori leg., det., ded., coll. E. 2478. *See* Ghidini, 1931, *Boll. Soc. ent. ital.* **63** : 40.—*L.* (*A.*) *mairei* Peyerimhof. *See* Boldori, 1935, *Bull. Soc. ent. France* **40** : 150.—*L.* (*Ceuthosphodrus*?) sp. 1 L (hw. 1·29) France : Grotte de Trouleat, Ht. Pyrén., 29.ix.31, under stones in dark part, G. de Kerville leg., M.P.

Calathus fuscipes Goeze. 2 L II (hw. 1·46–1·54), 4 L III (hw. 1·59–1·67–1·76), 1 L III about to pupate (hw. 1·61) Germany : Riesa on Elbe, mid v.35, in soil of garden, W. Döhler, coll. E. 1863 and B.M.; 1 exuv. III (hw. 1·65) same data, 18.iv.36, pupated 27.iv., ♂ hatched 7.v.36; coll. E. 1801.—1 L II on slide (hw. *c.* 1·52) Pasing, nr. Munich, 7.v.24, in garden, K. W. Verhoeff leg., B.M.—*C. fuscipes* Goeze? 1 L II? (hw. 1·5) Windsor Forest, 14.iv.39, H. Donisthorpe leg., B.M.—1 L I (hw. 0·84) Germany : Kohren, Saxony, Stöckigt wood, 5.i.31, sifted, O. Michalk leg., ded., coll. E. 923 b.—1 L II ? (hw. 1·5) Schönau, nr. Leipzig, 17.i.32, sifted in sand-pit, O. Michalk leg., ded., coll. E. 918.—*C. erratus* Sahlberg. 1 L I (hw. 0·71) Denmark: Ballerup, ♀ found 25.viii.29, eggs deposited 1.ix., larva 27.ix., E. Rosenberg educ., det., ded., coll. E. 849. Egg-bursters keel-shaped.—*C. micropterus* Duftschmid ? 1 L III ? (hw. 1·07) Germany: Dreiannen-Hohne, Harz Mts., 24.ii.22, under bark of spruce, K. Dorn leg., ded., coll. E. 617.—*C. kollari* Putzeys, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2**: 197.—*C.* spp. 1 L I (hw. 0·69) Germany: nr. Berlin, 3.x.36, under bark of *Alnus*, Otten leg., Korschefsky ded., coll. E. 2876. Egg-bursters spine-shaped.—3 L I (hw. 0·55–0·56–0·57) Walkenried, S. Harz Mts., 1.viii.20, K. Dorn leg., ded., coll. E. 214. Egg-bursters spine-shaped.—1 L (hw. 1·03) Berlin-Marienfelde, iv.35, in soil of field, Korschefsky leg., ded., coll. E. 1726.—1 L (hw. 1·03) Gundorf, nr. Leipzig, 28.ii.22, coll. E. 650.—2 L (hw. 1·07) Leipzig, Zeppelin-Bridge, 1.i.20, coll. E. 295, 296.—1 L (hw. 1·05) Bonn on Rhein, 8.iii.37, in stomach of mole, Schaerffenberg leg., Emd. det., B.M.—1 L (hw. 0·96) nr. Wittenberge, Korschefsky leg., ded., coll. E. 1723.—1 L (hw. 0·88) Berlin-Gross-Lichterfelde, 18.iv.36, from poor soil of meadow, Korschefsky leg., ded., coll. E. 1795.—1 L (hw. 0·73) Kohren, Saxony, Stöckigt Wood, 5.i.31, sifted, O. Michalk leg., ded., coll. E. 923a.—1 L (hw. 0·71) France: Maisons Laffitte, 7.ii.38, in gallery of mole, L. Levasseur leg., M.P.

Platyderus sp. ? 1 L III ? (hw. 1·15) Algeria: S. Charles, Théry leg., M.P. This larva has characters of *Agonum* (inner lobe with apical seta), *Feronia* (membranous area of stipes maxillaris) and of the *Calathus*-group (pale tergites, rather short epicranial suture, small second joint of maxillary palpi), it seems therefore probable that it is a species of *Platyderus*.

Odontonyx rotundatus Paykull. 1 L I on slide (hw. 0·53) C. Europe, vii., sifted from decaying spruce-needles, Verhoeff, B.M.—1 exuv. III (hw. 0·91), 1 I. Denmark: N. Sjaelland, Meinert leg., M.C.

Agonum (*Anchomenus*) *ruficorne* Goeze. 2 L III, 2 exuv. III (hw. 1·10–1·13–1·15) Denmark: Seeland, E. Rosenberg leg., M.W.—1 L III (hw. 1·12) Madeira: Riv. Gomes, 18.iv.29, B.M.—*A.* (*Limodromus*) *assimile* Paykull. 3 L III, 1 exuv. III (hw. 1·67–1·71–1·74) Denmark: Dyrehavn, nr. Copenhagen, 7.vii.08, W. Schlick leg., M.W.—? 1 L III (hw. 1·71) Switzerland: Champéry, Wallis, M. Bänninger leg., ded., coll. E. 1028.—*A.* (*Agonum*) *moestum* Duftschmid. 1 L III on slide (hw. 1·22) Germany: Pasing, nr. Munich, Verhoeff, B.M.—? 1 L III (hw. 1·26) Britain, no locality, M. G. S. Perkins leg., B.M.—*A.* (*A.*) *mülleri* Herbst. 1 exuv. III on slide (dissected) Germany: Aubing, nr. Munich, bank of a pond, Verhoeff, B.M.—*A.* (*A.*) *ericeti* Panzer ? 1 L I (hw. 0·50) E. Prussia, Zehlau-Bruch, 7.vi.13, sifted from Sphagnum, A. Dampf leg., E. Skwarra ded., coll. E. 739.—*A.* spp. 1 L (hw. 1·12) Aviemore, vi.–vii.34, K. G. Blair leg., B.M.—1 L (hw. 1·04) Braunton, N. Devon, vi.31, K. G. Blair leg., B.M.—1 L (hw. 1·22) Britain ?, K. G. Blair leg., B.M.—1 L (hw. 1·21) Germany: Freiberg, Saxony, 29.viii.21, on damp bank under stone, H. Dietze leg., ded., coll. E. 242.—1 L I (hw. 0·83) Dübener Heide, Pretzschau, 11.vii.20, in fallow soil, K. Dorn leg., ded., coll. E. 246.—2 L II (hw. 0·73–0·74), 2 L III (hw. 1·13–1·17) Austria: Waidhofen on Ybbs, 15.viii.–15.ix.20, F. Netolitzky leg., ded., coll. E.—1 L III ? (hw. 1·62) Switzerland: San Bernardino Pass, M. Bänninger leg., ded., coll. E. 584.—1 L III ? (hw. 1·62) San Bernardino village, M. Bänninger leg., ded., coll. E. 582.—6 L of different species and from various localities in France, M.P.—1 L II or III (hw. 1·06) Morocco: Tachdirt, Ht. Atlas, 2500 m., 27.viii.37, Paulian et Villiers leg., M.P.

Orthotrichus indicus Bates (*see* Gardner, 1931, *Indian Forest Rec.* (*Ent.*) **16** : 91).

Abacetus (pars b) *iricolor* Andrewes, *see* Gardner, *loc. cit.* (n.s.) (*Ent.*) **2** : 192. It is difficult, from the known characters, to distinguish this larva from *Feronia* (see p. 64).

Genus indet. 3. 1 L II or III (hw. 2·79) French Indo-China, Vitalis de Salvaza 1917, M.P. Ex systemate, patria, magnitudine this can obviously only be a genus of Trigonotomina or perhaps Morionina.

Abax ater Villers. 1 L III (hw. 3·00) Limpsfield Common, Ridlands Wood, Surrey, 7.xi.37, H. Oldroyd leg., B.M.—1 L III (hw. 3·14) England, B.M.—1 L III dissected, on slide, C. Europe, Verhoeff, B.M.—1 L II on slide (hw. *c.* 2·09) Germany : Planegg, 7.v.21, Verhoeff, B.M.—1 L II (hw. 1·95), 3 L III (hw. 2·72–2·80–2·90) Hannover, 20.vii.91, K. Jordan leg., B.M.—3 L III (hw. 2·87–3·01–3·16) Dübener Heide, Zadlitzbruch, 21.v.33, in trenches dug to trap *Hylobius*, O. Michalk leg., ded., coll. E. 1101.—1 L III (hw. 2·87) Wüstegiersdorf, Silesia, 9.x.15, coll. E. 67.—1 L III (hw. 2·87) Zeyern, N. Bavaria, viii.21, K. Dorn leg., ded., coll. E. 250.—1 L III dry (hw. 2·76) Schkeuditz, nr. Leipzig, 22.vi.18, coll. E.; 1 L I dry (hw. 1·3) same data, 13.vii.18.—2 L II (hw. 1·87–2·13) Söllichau, Dübener Heide, 23.ix.24, under leaves, K. Dorn leg., ded., coll. E. 901.—1 L II (hw. 2·13) Grimma, Saxony, 1.vi.18, in soc. *A. ater* and *parallelus*, coll. E. 147.—1 L III (hw. 2·90) France : Château-neuf d'Ille-et-Vilaine, under leaves, K. Dorn leg., ded., coll. E. 236.—1 L III (hw. 2·90) Fontainebleau, iv., at base of tree, R. Paulian leg., M.P.—*A. parallelus* Duftschmid? 1 L II (hw. 1·53) Germany : Kösen on Saale, ix.19, coll. E. 442.

Molops piceus Panzer. 1 L II on slide (hw. 1·47) Germany : Planegg, 7.v.21, Verhoeff, B.M.

Evarthrus sigillatus Say. 1 L III, 1 exuv. III (hw. 2·34–2·42) U.S.A. : Washington, D.C., M.W.—*E.* (*Eumolops*) *sodalis* Leconte. 2 L III (hw. 2·20–2·34) U.S.A. : no locality, coll. Hamilton, M.W.

Trichosternus vigil White (*difformipes* Bates). 1 L II (hw. 2·37) New Zealand, 1931, G. V. Hudson leg., B.M.

Feronia (*Steropus*) *globosa* Fabricius? 1 L III (hw. 2·51) Morocco : Boubana, 3.iii., Buchet leg., M.P. Cervical groove entirely absent; median part of clypeus forming a very short and broad, bluntly triangular prominence, not at all emarginate in middle. In spite of the rather great differences between this larva and that of *madida* it can be no other species, as the adults of the other North African Pterostichini do not appreciably exceed 13 mm., except for *Percus lineatus* Solier, which, however, does not reach Morocco.—*F.* (*S.*) *madida* Fabricius. 1 L I (hw. 1·25) Kew, Surrey, 25.iii.40, in garden, coll. E. 2987; all the numerous other larvae of *F. madida* found on that date and at other times in spring, which were not preserved, were L III.—1 exuv. III (hw. 2·44) Britain, no locality, H. Main leg., adult hatched 23.v.37, B.M.—1 L III (hw. 2·35) London, B.M.—3 L III (hw. 2·30—2·38—2·48) Britain, iv.01, sent from Board of Agriculture, B.M.—9 L III (hw. 2·23–2·36–2·55) Britain, together with two L *F. melanaria*, B.M.—1 L III (hw. 2·37) St. Ives, Cornwall, K. Frazier leg., B.M.—1 L III (hw. 2·51) Fulham, London, B.M.—2 L III (hw. 2·48–2·51) England, B.M.—1 L III (hw. 2·48) Hove, v.32, Miss B. Hopkins leg., B.M.—1 L III (hw. 2·55) near Worthing, Miss F. Collins leg., B.M.—1 L I (hw. 1·22), 8 L II (hw. 1·50–1·68–1·84), 6 L III (hw. 2·27–2·43–2·57) France : Château-neuf d'Ille-et-Vilaine, K. Dorn leg., det. ex soc. imag., ded., coll. E. 238 (*see* Emden, 1936, *Bull. Mus. R. Hist. nat. Belg.* **12** (11) : 2; Raynaud, 1936, *Misc. ent.* **37** : (44)).—1 L III (hw. 2·30) Valenciennes Nord, iii.37, P. Beck leg., M.P.—1 L II (hw. 1·64) Vienne, xi.37, F. Pierre leg., M.P.

Cervical groove and keel present; nasale more or less emarginate, thus usually forming two slight, rounded lobes.—?1 L III (hw. 2·58) Basses Pyrénées, Ahusquy, grotte d'Istaourdy, viii.06, P. Nadar leg., M.P.—?1 L II (hw. 1·84), 2 L III, 1 exuv. III (hw. 2·3–2·44–2·63), 1 P ♂, same locality, viii.38, Paulian, Lepesme et Villiers leg., M.P. Last ventrite of ♂ P with a longitudinal keel over its entire length. This character is found in the adult of *F.* (*S.*) *ghilianii* Putzeys, but so far as I know, this species does not occur on the French side of the Pyrenees. The pupa may be malformed, or the transverse keel of the adult may be a longitudinal one in the pupa.—*F.* (*Feronia* s.str.) *lucublanda* Say. 1 exuv. III (hw. 1·66) U.S.A., coll. Hamilton 577, M.W., together with 1 L *F. muta* and 1 L *F. stygica*?—1 L II (hw. 1·39) U.S.A., coll. Hamilton 573, M.W. together with 2 L *F. muta.*—2 L II (hw. 1·29–1·36) Milwaukee, Wisc., 22.viii.37, Harry van Emden leg., coll. E. 2980 (fig. 23).—*F.* (*F.*) *cuprea* L., *see* Raynaud, 1936, *Misc. ent.* **37** : (53).—*F.* (*F.*) *coerulescens* L., *see* Raynaud, 1937, *loc. cit.* **38** : (57).—*F.* (*F.*) spp. 1 L III (hw. 1·88) Germany : Dübener Heide, Pretzschau, 11.vii.20, in fallow soil, K. Dorn leg., ded., coll. E. 244.—1 L III (hw. 2·13) Abtshagen, 5.x.25, H. Blunck leg., ded., coll. E. 935.—1 L III (hw. 1·95) Dübener Heide, 5.viii.23, debris at bank in wood, H. Dietze leg., ded., coll. E. 2400.—*F.* (*F.*) *gebleri* Dejean? 2 L III (hw. 2·62–2·90) Peking, mountains, A. David leg., M.P.—*F.* (*Pseudorthomus*?) *unctulata* Duftschmid? 1 L II (hw. 0·84) Glatzer Schneeberg, Silesia, 30.vii.36, under decaying needles of spruce above Schnelle-stream, F. Pax leg., ded., coll. E. 2455. This larva is rather puzzling, the maxillae are without a membranous area near base of ventral surface, but the seta of the outer lobe is very distinctly lateral. The pigmented spots of the second row of ocelli are smaller, the epicranial suture longer than the fourth antennal joint, the cervical groove strongly produced forward on ventro-lateral surface. Ex loco et magnitudine it is very probable that this is *unctulatus.*—*F.* (*Parargutor*) *lustrans* Leconte. 1 exuv. III (hw. 1·78) U.S.A. : Tanforan, Calif., 30.vi.34, pupal and larval skin in mud-cell, P. Ting leg., ded., Van Dyke det. adult, M.W.—*F.* (*Refonia*) *superciliosa* Say. 6 L III (hw. 1·99–2·06–2·2) U.S.A., coll. Hamilton 59–64, M.W.—*F.* (*Omaseus*) *melanaria* Illiger. 1 L II (hw. 1·99), 2 L III (hw. 2·62) Britain, together with 9 L *madida*, B.M.—1 L II (hw. 1·71) Britain, K. G. Blair leg., B.M.—1 L III (hw. 2·58) England "larva of *Pterostichus madidus*," Emd. det., B.M.—1 L III, 2 exuv. III (hw. 2·37–2·44–2·55) France : Versailles, i.32, L. Mesnil leg., ded., adult hatched 22.iii., coll. E. 903, *see* Emden, 1936, *Bull. Mus. R. Hist. nat. Belg.* **12** (11) : 2.—1 L II (hw. 1·88) Aurigny, Mare de la Canière Manny, 6.ix.36, H. Bertrand leg., M.P.—?1 L II (hw. 1·67) Lampaul-Plouarzel, Finistère, 14.vii.37, under stones on dunes, M.P.—1 L III (2·76) Germany : Wüstegiersdorf, Silesia, 15.iv.17, coll. E. 88.—1 L III (hw. 2·48) Harth-wood, S. of Leipzig, 3.iv.21, in root of *Lappa*, attacking caterpillars of *Hepialus humuli* L., M. Müller leg., ded., coll. E. 401.—1 L II (hw. 1·74) Leissling, nr. Weissenfels, E. Thurin., 11.ix.21, in nest of hamster, K. Dorn leg., ded., coll. E. 198.—*F.* sp. nr. *melanaria* Illiger? 1 L III (hw. 2·34) Caucasus, nr. Maltchik, gouv. Tarek, Bezenghi Tarnogradsky leg., M.P.—*F.* (*Bothriopterus*) *oblongopunctata* Fabricius. 1 L I (hw. 0·80) Denmark : Jägerspris, hatched from egg 25.vi.28, Rosenberg educ., ded., coll. E. 779.—1 exuv. III dissected, on slide C. Europe, Verhoeff, B.M.—*F.* (*Lyperosomus*) *aterrima* Dejean, *see* Raynaud, 1936, *Misc. ent.* **37** : (43).—*F.* (*Euferonia*) *stygica* Say. 1 L III, 1 exuv. III (hw. 1·95–2·09), 1 I. U.S.A., coll. Hamilton 298, M.W.—1 L II? (hw. 1·73) U.S.A., coll. Hamilton 577, together with 1 L *F. lucublanda* and 1 L *F. muta*, M.W.—*F.* (*Argutor*) *diligens* Sturm? 1 L III (hw. 1·08) Germany : Grosser Kranichsee, W. Erzgebirge, 18.vi.29, sifted from *Sphagnum*, coll. E. 1333, *see* Emden, 1932, *Col. Rundsch.* **18** : 148.—1 L III (hw. 0·87) same data, 4.vii.29, coll. E. 957.—1 L I (hw. 0·44) Silesia, marsh on the Puhu, 27.v.34, K. Schubert leg., ded., coll. E. 1385.—1 L I (hw. 0·44), 2 L III (hw. 0·87–0·91) Zehlau-Bruch, E. Prussia, 10.vii.21, sifted from *Sphagnum*, A. Dampf leg., E. Skwarra ded., coll. E. 738, *see* Emden and Emden, 1929, *Schrift. phys.-ökon. Ges. Königsb.* **66** (2) : 276.—1 L I (hw. 0·42) Glatzer Schneeberg, Puhu, marshy meadow nr. Heudorf, 23.vii.35, F. Pax leg., ded., coll. E. 2434.—*F.* (*Pseudomaseus*) *corvina* Dejean. 1 exuv. II (hw. 1·29), 3 L III (hw. 1·74–1·85–1·92) U.S.A., coll. Hamilton 542–545, M.W. Nasale very similar to that of *melanaria*.—*F.* (*Pseudomaseus*) *nigrita* F. 1 L III (hw. 1·64) C. Europe, Verhoeff, B.M.—1 L III on slide (hw. 1·85) Germany : Aubing, 25.vi.21, Verhoeff, B.M.—1 exuv. III, dissected, on slide same data, 8.ix.20, B.M. The ligula has two setae, although Raynaud (1936, *Misc. ent.* **37** : (41)) describes the ligula of *nigrita*, *aterrima*, *coerulescens* and *cuprea* as having only one seta. In my opinion, this character needs confirmation, as I have not seen it in the material I have studied; the two setae are often very closely adjacent, especially in sbg. *Poecilus*.—*F.* (*P.*) *nigrita* Fabricius ? 1 L III (hw. 1·92) Windsor Forest, 29.ix.36, H. Donisthorpe leg., ded., B.M.—*F. nigrita* Fabricius ? or *gracilis* Dejean ? 2 L I (hw. 0·66) Trefriw, Carnarvonshire, N. Wales, 6.vi.41, J. Balfour-Browne leg., ded., B.M.—*F.* (*Bothriopterus*, *Pseudomaseus* etc.) spp. 2 L I (hw. 1·23–1·33), 1 L II (hw. 1·92) Walkenried, S. Harz Mts., 1.viii.20, K. Dorn leg., ded., coll. E. 203, 205.—2 L (hw. 2·09–2·2) Zeyern, 16–17.iv.22, K. Dorn leg., ded., coll. E. 855.—1 L (hw. 1·40) Ueckeritz, Usedom, 5.vii.36, from cow-dung, Korschefsky leg., ded., coll. E. 2372.—1 L (hw. 1·28) Doberschützer Moor, nr. Eilenburg, 13.vii.22, K. Dorn leg., ded., coll. E. 1070.—1 L (hw. 1·5) Doberschützer Moor nr. Eilenburg, 1.vii.18, from *Sphagnum*, coll. E. 161.—1 L III ? (hw. 1·88) Eulengebirge, Hohe Eule, 19.v.18, coll. E. 143.—1 L I (hw. 0·80), 1 L II (hw. 1·15) Doberschützer Moor nr. Eilenburg, 1.vii.18, from *Sphagnum*, coll. E. 162–3.—1 L (hw. 1·99) Zeschwitz S. of Leipzig, 27.vi.15, on road, coll. E. 63. Epicranial suture practically absent.—1 L I (hw. 0·64) France : Bonneuil, S.-O., L. Levasseur leg., M.P.—1 L (hw. 2·06) Marly, S.-et-O., 18.x.37, F. Pierre leg., M.P.—1 L (hw. 2·72) Fontainebleau, iv., R. Paulian leg., M.P.—2 L (hw. 1·78–1·95) Switzerland : Albrun-Pass, Binnental, 2400 m., M. Bänninger leg., ded., coll. E. 870.—*F.* (*Pterostichus*) *multipunctata* Dejean. 2 L I (hw. 1·10–1·12) Italy : Campiglio, Trento, vii.33, L. Boldori leg., det., ded., coll. E. 1919. *See* Boldori, 1933, *Studi Trentini Sci. nat.* **14** : 222 ; Raynaud, 1936, *Misc. ent.* **37** : (51).—*F.* (*P.*) *femorata* Dejean, *see* Raynaud, *loc. cit.* : (48).—*F.* (*P.*) *dufouri* Dejean, *see* Raynaud, *loc. cit.* : (49).—*F.* (*P.*) *fossulata welensi* Drapiez. 1 L III (hw. 2·97) S. Bucowina : Summit of Mt. Rareu, Netolitzky leg., ded., coll. E. 2648.—*F.* (*Steropus*) *aethiops* Panzer. 1 L II, dissected, on slide (hw. *c.* 1·47) Germany : Riessersee, 17.ix.20, under bark of spruce, Verhoeff, B.M.—1 L III dissected on slide (hw. *c.* 2·5), C. Europe, Verhoeff, B.M.—*F.* (*Dysidius*) *muta* Say. 1 L I, head on slide, 1 L I (hw. 1·22–1·29) U.S.A., coll. Hamilton 573, M.W., together with 1 L *F. lucublanda*.—1 L II (hw. 1·60) U.S.A., coll. Hamilton 577, together with 1 L *F. lucublanda* and 1 L *F. stygica* ?, M.W.—*F.* (*Pterostichus* etc.) spp. 1 L II (hw. 1·34), 1 L III (hw. 1·95) Austria : Totengebirge, 27.vii.32, Netolitzky leg., ded., coll. E. 1008.—1 L I (hw. 0·94), 1 L II (hw. 1·43) France : Col de la Cayolle, Alp. mar., 23.viii.34, R. Jeannel leg., M.P.—1 L (hw. 1·81) Aix-les-Thermes, Ariège, A. Dolfus, M.P.—1 L (hw. 1·74) Switzerland : Champéry sous la Dent, Valais, 7.viii.37, Méquignon leg., M.P.—*F.* (*Pterostichus*) *melas* Creutzer. 1 exuv., dissected, on slide, C. Europe, Verhoeff, B.M.—*F.* (*Pterostichus*) *cristata* Dufour ? 1 L II (hw. 1·8) Belgium : Yvoz-Ramet, Caverne aux Végétations, 5.xi.33, R. Leruth leg., Mus. R. Hist. nat. Belg.; 1 L III (hw. 2·5) (Grande Caverne de Fond-de-Forêt (caverne gauche), 1.v.32, at entrance under stones, R. Leruth leg., ded., coll. E. 1917, *see* Emden, 1936, *Bull. Mus. R. Hist. nat. Belg.* **12** (11) : 1.—*F.* (*Pterostichus*) spp. 1 L (hw. 1·57) France ?, M.P.—1 L (hw. 2·44) Poland : Tatra Mts., Five Lakes Valley, 5.vii.32, D. Aubertin and E. Trewavas leg., B.M.—1 L (hw. 0·68) Britain ?, K. G. Blair leg., B.M.—1 L (hw. 1·92) Germany : Gross-Baum, Labiau, E. Prussia, xii.35, under mossy stones in mixed wood, Korschefsky leg., ded., coll. E. 1760.—2 L (hw. 2·16–2·28) Switzerland : Faulhorn, Berner Alps, M. Bänninger leg., coll. E. 867.—1 L (2·30) Dôle, Jura, M. Bänninger leg., coll. E. 1136.—1 L (hw. 1·72) Bucowina : Czernowitz, 7.vii.21, banks of river Pruth, F. Netolitzky leg., ded., coll. E. 666.—*F.* (*Abacidus*) *permunda* Say. 1 L III, 1 exuv. III (hw. 1·57–1·67), 1 I., U.S.A. : coll. Hamilton 164,M .W.—2 L I (hw. 0·84–0·91) Milwaukee, Wisc., 8–9.vi.35, Harry van Emden leg., ded., coll. E. 2489.

Zabrus tenebrioides Goeze. 6 L I newly hatched (hw. (0·94) 1·17–1·20–1·26) C. Europe, Verhoeff, B.M.; 1 L I strongly pressed, on slide (hw. 1·43) 1.ix.22, Verhoeff, B.M. (fig. 31).—1 L I dry (hw. 1·12), 1 L II (hw. 1·61) Germany : Munzig, nr. Meissen, Saxony, 6.i.19, W. Zumpe leg., ded., coll. E. 175, 176.—8 L II (hw. 1·71–1·78–1·88), 16 L III (hw. 2·51–2·72–2·86) nr. Halle on Saale, 1930, in grain-fields, K. R. Müller leg., ded., coll. E. 818 and B.M.—5 L III (hw. 2·51–2·76–2·86) Kunnersdorf, nr. Leipzig, University-farm, coll. E. 864.—*Z.* (*Pelor*) *blapoides* Creutzer, *see* Znoiko, 1935, *Rev. Ent. URSS.* **25** : 232.—*Z.* (*Iberozabrus*) *obesus* Dejean, *see* Raynaud, 1937, *Misc. ent.* **38** : (66). These three species without cervical groove and keel.—*Z.* (*Macarozabrus*) *crassus* Dejean ? 1 L III (hw. 3·07) Tenerife, C. Alluaud leg., M.P. Cervical groove and keel present. Cerci moderately short.

Amara (*Percosia*) *obesa* Say. 10 L III (hw. 1·95–2·13–2·29), 3 P. U.S.A. : Morristown, Rice Co., Minn., S. H. Henry leg., M.W.—*A.* (*P.*) *equestris* Herbst. 1 L II, 1 L II dry (hw. 1·60–1·61) Germany : Röhnberg, nr. Gotha, Thuring., 20.x.20, K. Dorn leg., ded., coll. E. 201.—1 L II (hw. 1·54) Zeyern, 14.iv.22, K. Dorn leg., ded., coll. E. 485.—1 L II (hw. 1·43) Schönau, nr. Leipzig, 12.iii.32, in sand-pit, O. Michalk leg., ded., coll. E. 1023. *See* Znoiko, 1929, *Plant Prot.* **6** : 335.—*A.* (*P.*) sp. Russia : Baikal Region, Mission Paul Labbé leg., M.P.—*A.* (*Cyrtonotus*) *aulica* Panzer. 2 L I (hw. 1·39–1·46) C. Europe, Verhoeff, B.M.; 1 L I on slide (hw. 1·48), same data, 28.ix.23; 1 L I (hw. 1·58) same data, 30.ix.20.—2 L III (hw. 2·48–2·59) Belgium : Joudreville, 24.xii.16 (adult collected 28.xii.), K. Dorn leg., ded., coll. E. 81–82.—1 L III (hw. 2·7) Germany : Wüstegiersdorf, Silesia, 5.iv.17, coll. E. 86.—1 L I (hw. 1·5) Crossen, 17.viii.24, K. Dorn leg., ded., coll. E. 1112.—*A.* (*C.*) *convexiuscula* Marsham ? 1 L III (hw. 2·06) Sülldorf, nr. Magdeburg, viii.21, C. Urban leg., ded., coll. E. 660.—*A.* (*C.*) *gigantea* Motschulsky ? 1 L III (hw. 4·6) China : Peking, Mountains, A. David leg., M.P. The cervical groove is bent forward at side-margin of head and extends forward in straight direction almost to the ocelli.—*A.* (*Amara* s.str.) *similata* Gyllenhal. 3 L I, 1 L I on slide (hw. 0·68–0·69) C. Europe, Verhoeff, B.M.—1 L III, 1 exuv. III on slides (hw. *c.* 1·26) Germany : Aubing, 6.viii.21, at pond, Verhoeff, B.M.—*A.* (*A.*) *aenea* Degeer, *see* Boldori, 1935, *Boll. Soc. ent. ital.* **67** : 150; Branchini, 1938, *Boll. Zool. Torino* **9** : 215.—*A.* (*A.*) spp. 3 L (hw. 1·13) S. Kensington, 10.viii.34, Turpin leg., B.M.—1 L I (hw. 0·64) 2 L II (hw. 0·94), 4 L III (hw. 1·26–1·31–1·41) Germany : Dübener Heide, nr. Eilenburg, 11.vii.20, K. Dorn leg., ded., coll.

E. 243.—1 L (hw. 1·16) same data, obviously a different species.—4 L (hw. 1·29–1·34–1·39) Gundorf, nr. Leipzig, 28.ii.27, in flood refuse, coll. E. 589.—2 L II (hw. 0·83), 1 L III (hw. 1·16) Bienitz, nr. Leipzig, 29.v.36, O. Michalk leg., ded., coll. E. 2667–8.—1 L II (hw. 1·43), 1 L III (hw. 1·88) Leipzig-Gross-Zschocher, 13.iii.33, O. Michalk leg., ded., coll. E. 1081.—3 L (hw. 1·31–1·37) Gundorf, nr. Leipzig, 28.ii.22, in flood refuse, coll. E. 649.—1 L (hw. 1·91) Zwenkau, nr. Leipzig, 2.vi.15, coll. E. 196.—1 L II (hw. 1·28), 1 L III (hw. 1·88) Naumburg on Saale, 10.ii.21, H. Maertens leg., ded., coll. E. 409.—1 L (hw. 0·97) Walkenried, S. Harz Mts., 1.viii.20, K. Dorn leg., ded., coll. E. 215.—1 L (hw. 0·66) France: Ile d'Yeu, Vendée, 12.vii.37, under dung-heap, R. Paulian leg., M.P.—1 L (hw. 1·15) Plouarzel, Finistère, dunes of Portévigné, 17.viii.37, G. Lemasne leg., M.P.—1 L (hw. 1·19) Benhou, 2.ix.36, H. Bertrand leg., M.P.—2 L I (hw. 0·73–0·78) Italy: Ischia, Neapel, O. Michalk leg., coll. E. 1946.—2 L I (hw. 0·9–0·98) Labrador: Akpatok Is., B.M.—*A.* (*Celia*) *musculus* Say. 1 exuv. III, 2 L III (hw. 1·0–1·2), 1 P., U.S.A.: Havre de Grace, Md., 22.iv.36, W. H. Anderson leg., M.W.—*A.* (*C.*) *bifrons* Gyllenhal. 5 exuv. III, 8 L III (hw. 1·05–1·11–1·20) Germany: Riesa on Elbe, iv.–v.36, in soil of garden, W. Döhler leg., ded., Emden educ., coll. E. 1847.—*A.* (*C.*) *ingenua* Duftschmid. 1 exuv. I on slides (hw. *c.* 1·125), 1 exuv. II (last exuvia of this larva, hw. 1·95) pregnant ♀ from Gundorf, nr. Leipzig, 7.iii.22, eggs deposited 9.iii,; hatched 27.iii.; 1st exuvia shed 5.iv.; pupated 21.iv. During incubation the longitudinal diameter of the eggs increased by one-seventh to one-fifth, the transverse diameter by one-quarter to one-third, the head-width of the newly-hatched larva was one-sixteenth wider than the width of the newly deposited egg, coll. E. 681.—*A.* (*C.*) *quenseli* Schönherr? 1 L III (hw. 1·22) Austria: Stubaier Alps, Alpein, together with adults of *A. quenseli*, H. Janetschek leg., ded., B.M. Nasale and cervical groove as in sbg. *Percosia*.—*A.* (*C.*) spp. 2 L I (hw. 0·88) Germany: Bienitz, nr. Leipzig, 18.iii.31, O. Michalk leg., ded., coll. E. 907.—2 L (hw. 1·10–1·12) Berlin-Marienfelde, iv.37, from soil of field, Korschefsky leg., ded., coll. E. 2540.—*A.* (*Bradytus*) *consularis* Duftschmid. 3 L I (hw. 0·9–0·94) C. Europe, Verhoeff, B.M. (fig. 67). Egg-bursters, *see* Boldori, 1935, *Boll. Soc. ent. ital.* **67**: 150.—1 L III (hw. 1·7) Beer, S. Devon, iv.30, K. G. Blair leg., B.M.—*A.* (*B.*) *fulva* DeGeer. 4 L III, 3 exuv. III (hw. 1·6–1·71–1·8), one of them somewhat doubtful, as head with an angle as in *Percosia*, but other characters of *fulva*: Germany: Riesa on Elbe, iv.–v.36, in soil of garden, W. Döhler leg., adults bred, coll. E. 1848 (fig. 10). Egg-bursters, *see* Boldori, *loc. cit.*—?1 L II (hw. 1·31), 6 L III (hw. 1·67–1·78–1·84) Bucowina: Czernowitz, 8.xi.36, Netolitzky leg., ded., coll. E. 2337.—*A.* (*B.*) *apricaria* Paykull. 5 exuv. III, 40 L III (1·27–1·38–1·43) Germany: Riesa on Elbe, iv.–v.36, in soil of garden, W. Döhler leg., ded., adults bred, coll. E. 1846.—1 L III, 1 exuv. III (hw. 1·37), 1 P. same data, 12–17.iv.36, coll. E. 2510.—*A.* (*B.*) *batesi* Csiki, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2**: 190. The chaetotaxy of the last ventrite is not known, but the cervical groove is present in this species.—*A.* (*B.*) *exarata* Dejean. 1 exuv. III, 1 L III (hw. 1·69–1·76), 1 ♂ I., U.S.A.: Urbana, Ill., coll. Hamilton, M.W.—*A.* ("*Leiocnemis*") *avida* Say. 1 exuv. III (hw. 1·73), 1 ♀ I., U.S.A., coll. Hamilton 134, M.W.—10 L III "*Amara avida* or *exarata*," coll. Hamilton 133–144, M.W. I have not been able to find a difference, certainly not one of subgeneric importance, between the exuviae of *exarata* and *avida*. The only male of the latter in my possession has distinct, fine, short hairs on the interior surface of the hind tibiae. Though these are not as dense as in the European species of *Bradytus*, the hind tibiae are nevertheless those of that subgenus, having a longitudinal strip of fine, dense pubescence on the inner (ventral in morphological sense) surface between the dorsal (postero-ventral) row of rather distant setulae and the ventral (antero-ventral) row of a few spinulose setae, whereas the tibiae of *Leiocnemis* are perfectly bare between these two rows of setulae. The only North American *Amara,* which has so far been regarded as a *Leiocnemis,* is therefore a *Bradytus,* and the extreme similarity of its larvae and those of the latter subgenus is explained very naturally.

Glyptus sculptilis Brullé, *see* Wasmann, 1902, *Zool. Jahrb.* (*Syst.*) **17** : 147.—Dimmock and Knab, 1904, *Springfield Mus. nat. Hist. Bull.* **1** : 1.

Orthogonius horni Wasmann. 2 L III cotypes (hw. 1·88) Ceylon, W. Horn leg., Mus. Dahlem ded., coll. E. 173, 174. Species founded on larva : Wasmann, 1902, *Zool. Jahrb.* (*Syst.*) **17** : 144.—*O. schaumi* Chaudoir. 4 L III (hw. 1·92–1·97–2·06) India : Coimbatore, 20.xii.28, feeding on young termites, M.S.K. leg., B.M. *See* Wasmann, *loc. cit.* : 142.—*O. termiticola* Wasmann, *see* Wasmann, *loc. cit.* : 145.—*O. assmuthi* Wasmann. 1 L III (hw. 1·81) no locality, H. E. Andrewes ded., B.M. (fig. 7).—*O. duplicatus* Wiedemann, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2** : 184.—*O.* spp. 1 L (hw. 2·2) Chilla, 30.xii.31, with *Termes obesus* Rambur, B.M.—2 L (hw. 2·02–2·09) Assam : Attabarrie Tea Estate, B. Hughes Hullett leg., B.M.—1 L (hw. 1·74) same data, a different species, B.M.—1 L (hw. 2·14) N. Angola : Bavaria Farm, Jos. Eberl leg., coll. E. 1161.

Amblystomus quadriguttatus Motschulsky, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2** : 189.

Dicheirotrichus pubescens Paykull. 2 L I (hw. 0·71–0·73), 13 L III ? (hw. 0·98–1·06–1·13) Denmark : Vesterfälden, 3.ix.95, M.C.—1 L I (hw. 0·73), 2 L III ? (hw. 1·07–1·13) Copenhagen, Vesterfälden, 23.x.95, W. Schlick leg., Rosenberg ded., coll. E. 934.—4 L III ? (hw. 0·96–0·99–1·01) G. Britain : Aberlady, 3.v.33, surface of marsh, B.M.—1 L III ? (hw. 0·98), 5 P., Germany : Borkum, v.37, in damp mound of earth, together with *Bledius,* Struve leg., Korschefsky ded., coll. E. 2878.

Anisotarsus sayi Blatchley. 35 L III (hw. 1·43–1·54–1·65) U.S.A., coll. Hamilton, M.W.

Trichopselaphus subiridescens Chaudoir ? 1 L III (hw. 1·37) Brazil : Sta. Catharina, Nova Teutonia, F. Plaumann leg., ded. The adult Harpalini collected by Herr Plaumann, which I have identified, belong to the genera *Polpochila, Notiobia, Anisotarsus, Trichopselaphus, Pelmatellus, Selenophorus* (incl. *Athrostictus*), *Gynandropus,* and *Bradycellus.* The second and third of these genera will probably be more closely related to the North American *Anisotarsus sayi, Polpochila* may be expected to be more isolated, *Selenophorus, Gynandropus* and *Bradycellus* to have no anterior keel on the tergites, and the species of *Pelmatellus* found in Sta. Catharina (like those of *Bradycellus*) to have a smaller head-width.

Anisodactylus binotatus Fabricius. 1 L II on slide (hw. *c.* 1·67), 1 L III (hw. 2·13) Germany : Aubing, at pond, Verhoeff, B.M.—*A. poeciloides* Stephens ? 1 L III (hw. 1·91) Sülldorf, nr. Magdeburg, 18.viii.23 or 21.viii.21, C. Urban leg., ded., coll. E. 1505.—*A.* spp. 1 L (hw. 2·13) France : Ile d'Yeu, Vendée, R. Paulian leg., M.P.—1 L (hw. 1·95) S. Abyssinia : Hicka, 2.iv.04, M. de Rothschild leg., M.P.

Amphasia interstitialis Say. 2 L III (hw. 1·8–1·82), 8 exuv. III (hw. 1·65–1·72–1·78), 9 P. U.S.A. : Ithaca, N.Y., 8.ix.17, Hamilton leg., M.W.

Trichocellus placidus Gyllenhal, *see* Kemner, 1913, *Ark. Zool.* **8** (13B) : 15. Plate 1, fig. 4 seems to indicate that the tergites are as in the *Anisodactylus*-

group, the distance between the anterior marginal line and the anterior row of setae being much smaller than the width of the praetergum would be. The latter, thus, has evidently not been drawn by Kemner.

Diachromus germanus L.? (or *Trichotichnus laevicollis* Duftschmid?). 3 L I (hw. 0·99–1·01), 1 L II (hw. 1·24) Germany: Walkenried, S. Harz Mts., 1.viii.20, K. Dorn leg., ded., coll. E. 211, 216. Of the genera of Harpalini occurring in the Harz Mts. *Anthracus, Bradycellus, Parophonus, Trichotichnus,* and *Diachromus* are unknown, and only the last three genera would fit the larvae by their size. *Trichotichnus* is the most common one of these genera in mountainous parts of Central Europe and has actually been found near Walkenried (Rapp, 1933, *Käf. Thüringens* **1** : 85), but *Diachromus* would better fit the size and the formation of the tergites of the larvae, as it belongs to Anisodactylina. The head of the first stage has been figured (Emden, 1925, *Z. wiss. Zool.* **126** : 628, fig. 9).

Barysomus? sp. 1 L I (hw. 1·39) Costa Rica: Reventazon, Hamburg Farm, 31.viii.36, at fruit [obviously fallen] of *Ficus glabrata*, F. Nevermann leg., ded., coll. E. 2971. Though there is as a rule no correlation between adult and larval characters in beetles, such a correlation seems to exist in the case of the emarginate clypeus of the Licinini and *Amblystomus*, and it may, therefore, be supposed that the present larva belongs to a genus of Harpalini with emarginate clypeus. The only two genera with this character, found in Costa Rica, are *Barysomus* and *Amblygnathus*, the former being much more common.

Euryderus zabroides Leconte. 1 exuv. III (hw. 4·1), 1 I., U.S.A.: Bangs, Tex., 26.x.37, Wm. H. Anderson leg., M.W.—1 L III (hw. 3·5) Bangs, Tex., 18.viii.37, L. O. Christenson leg., C-3277, M.W.—1 L II (hw. 2·14) Tucson, Ariz., Hubbard leg., M.W., labelled *Cratocara* (*Polpochila*) *capitata*? The larva is only very slightly different from the others, the nasale being rounded and somewhat projecting with two teeth on either side of the curvature, whereas in the other two it is truncate with a very slight emargination in middle and 1–2 blunt teeth at outer end. These differences are certainly not of generic importance, but may partly be due to the different stage, and partly to the front margin being worn in larvae about to pupate. Casey has described the form from Arizona as *arizonicus* Casey, but the differences from *zabroides* seem to be only slight. The deviations in the nasale of the larva may, therefore, partly be those of a subspecies.

Cratacanthus dubius Beauvois. 1 exuv. III (hw. 2·51), 1 I. U.S.A., coll. Hamilton 203, M.W.—1 L III (hw. 2·48) U.S.A., coll. Hamilton 202, M.W.

Harpalus (*Ophonus*) *puncticollis* Paykull. 1 L I (hw. 1·13) Verhoeff educ., Reichert ded., coll. E. 516.—1 L I on slide (hw. 1·19) Germany: Pasing, nr. Munich, 15.viii.22, Verhoeff, B.M.—3 L I (hw. 1·08–1·12–1·15) C. Europe, Verhoeff, B.M. There is little doubt that these larvae were bred, and they probably belong to one breeding experiment. Several species, formerly identified as *puncticollis*, have been separated since these larvae were bred, but as the adults are no longer available, they can only be ascribed to the *puncticollis*-group.—*H.* (*O.*) *azureus* Fabricius. 1 L II (hw. 1·47) Nördlingen, 2.vi.23, under thistle, Verhoeff, B.M.—*H.* (*O.*) *stictus* Stephens. 3 L I (hw. 1·28–1·29–1·31), 4 L II (hw. 1·65–1·75–1·84), 4 L III (hw. 2·40–2·49–2·63) France: Mogeville nr. Verdun, 18.ix.17, in soil of old shell-craters in soc. imag., K. Dorn leg., ded., coll. E. 153–7. Described as larva of *O. diffinis* Dejean by me (1920, *Arch. Naturges.* **84** (A) (10) : 150).—1 L II on slide (hw. 1·95) Verdun, 18.ix., Verhoeff, B.M. (labelled *O. diffinis*, obviously given to Dr. V. by me).—

H. (*O.*) spp. 3 L (hw. 1·46–1·54–1·58) Berlin, iv.37, from soil of a field, Korschefsky leg., coll. E. 2539.—2 L (2·37–2·41) Switzerland: Denens s. Morges, Canton Vaud, v.37, attacking roots of vine, P. Bovey ded., B.M.—*H.* (*Pseudophonus*) *rufipes* Degeer (*pubescens* Müller). 1 L III (hw. 3·11) Britain, reported destroying potatoes, B.M.—3 L I (hw. 1·85–2·08–2·30) C. Europe, Verhoeff, B.M.—3 L I, 1 exuv. I (hw. 2·01–2·10–2·18), 3 L II (hw. 2·4–2·48–2·59), 9 L III (hw. 2·83–2·92–3·01) Germany: Riesa on Elbe, iv.35.–v.36, in soil of garden, W. Döhler leg., ded., coll. E. 1850.—1 L I (hw. 2·03) same data, x.36, coll. E. 2493.—2 L II (hw. 2·85–2·89) same data, 12–17.iv.36, coll. E. 2511.—1 exuv. I (hw. 2.18) Leipzig, Burgaue, 25.x.23, K. Dorn leg., ded., coll. E.—1 L II (hw. 2·78) Leipzig-Klein-Zschocher, 6.xi.34, O. Michalk leg., ded., coll. E. 1392.—1 L I, head on slide (hw. 2·36) K. W. Verhoeff educ., ded., coll. E. 200.—1 L I (hw. 2·1) K. W. Verhoeff educ., Reichert ded., coll. E. 517. *See* Znoiko, 1929, *Plant Prot.* **6** : 335; 1935, *Rev. Ent. U.R.S.S.* **25** : 235.—*H.* (*Pardileus*) *calceatus* Duftschmid. 1 L I (hw. 1·54) Germany: Berlin-Marienfelde, in soil of field, iv.35, Korschefsky leg., ded., coll. E. 1725. *See* Znoiko, 1935, *Rev. Ent. U.R.S.S.* **25** : 235.—*H.* (*P.*) *indicus* Bates, *see* Gardner, 1938, *Indian Forest Rec.* (n.s.) (*Ent.*) **3** : 151.—*H.* (*P.*) *compar* Leconte? 1 L III (hw. 3·0) U.S.A.: Milwaukee, H. van Emden leg., ded., coll. E. 1347.—*H.* (*Harpalus*).—*a. Mandible with auxiliary tooth*: *H.* (*H.*) *rufitarsis* Duftschmid. 1 L I on slide (hw. 1·22) Germany: Pasing, nr. Munich, vi.23, K. W. Verhoeff, B.M.—*H.* (*H.*) *rubripes* Duftschmid. 1 L I on slide (hw. *c.* 1·19) C. Europe, 16.vi.22, Verhoeff, B.M.—?1 L III (hw. 2·09) Britain?, B.M.—?1 L I (hw. 1·12) St. Merryn, vii.25, K. G. Blair leg., B.M.—*H.* (*H.*) spp. 1 L II (hw. 1·41), 4 L III (hw. 1·76–1·83–1·88) U.S.A., coll. Hamilton 202, 207, M.W.—2 L II (hw. 1·39–1·44), 11 L III (hw. 1·91–2·01–2·18) Germany: Berlin-Gross-Lichterfelde, 18.iv.36, poor soil of meadow, Korschefsky leg., ded., coll. E. 1796.—1 L (hw. 1·67) Seeburg, Mansfeld, 15.viii.21, under stone, H. Dietze leg., ded., coll. E. 378.—1 L (hw. 2·18) Limbach, Vogtland, Saxony, 22.viii.21, under stone, H. Dietze leg., ded., coll. E. 405.—1 L (hw. 1·58) Saxon Switzerland, north of the Felsenmühle (Kirnitzsch-area), 31.x.21, in soil of meadow, K. Dorn leg., ded., coll. E. 319.—2 L (hw. 1·52–1·6) Gross-Baum, Labiau, E. Prussia, xii.35, in wood under stone. Korschefsky leg., ded., coll. E. 1759. In these larvae, and the preceding one, two auxiliary teeth are present, the distal one weak; characters, therefore, are very similar to *Pseudophonus*, but head less broad, much more rounded, and less narrowed behind.—*b. Mandible without auxiliary tooth*: *H.* (*H.*) *honestus* Duftschmid. 1 L I, 1 L I on slide (hw. 1·05–1·08) C. Europe, Verhoeff, B.M.—1 L II on slide (hw. 1·5) same data, 16.vi.22, B.M. It is remarkable that the larva of *honestus* should differ so strongly from that of *rufitarsis*, that the latter and *rubripes*[34] should be so similar, and that *latus* should be more similar to *honestus* than to *rubripes*. Perhaps a mistake has been made by Dr. Verhoeff with these species.—*H.* (*H.*) *latus* L. 2 L III on slides (hw. 1·99–2·58) Aubing, nr. Munich, at pond, Verhoeff, B.M. I am practically certain that these are actually *H. aeneus* L.—*H.* (*H.*) *aeneus* L. 1 L I (hw. 1·2), 8 L II (hw. 1·57–1·66–1·76), 35 L III (hw. 1·99–2·33–2·59), sexed exuv. III, from which adults were raised by me, Germany: Riesa on Elbe, iv.–v.36, larvae in soil of garden, W. Döhler leg., ded., coll. E. 1849, 2512.—4 L I (hw. 1·28–1·30–1·35), 1 exuv. II (hw. 1·65), 2 L III (hw. 1·91–2·18) Dresden-Klein-Zschachwitz, L. hatched from egg 26.vi., preserved respectively, 27.vi., 27.vii., 8.ix.35, coll. E. 1880.—4 L I (hw. 1·40–1·44–1·47) C. Europe, Verhoeff, B.M.—*H.* (*H.*) *aeneus* L. ? 1 L III (hw. 2·41) Shanklin, I.O.W., v.30, K. G. Blair leg., B.M.—1 L I (hw. 1·26) S. Kensington, viii.34, S. J. Turpin leg., B.M.—1 L III (hw. 2·44) New Forest, 1.i.31, J. E. M. Mellor leg., B.M.—2 L III (hw. 2·27) Hendon, 12.vi.32, in garden paths, beetles also present, K. G. Blair leg., det., B.M.—1 L I (hw. 1·19) Britain ?, B.M.—2 exuv. III (hw. 2·13–2·30), 3 P. Germany: Lausa, nr. Dresden, in garden, coll. E. 827.—1 L III (hw. 2·23) Lübeck, Siemss leg., coll. E. 1387.—1 L III (hw. 2·30) Büsum, North Sea, vi.21, C. Urban leg., ded., coll. E. 248.—1 L III (hw. 2·13) Sachsenburg, 22.v.32, on roots of *Plantago maritima*, H. Gebien leg., Emd. det., Mus. Hamburg ded., coll. E. 1163.—1 L III (hw. 2·46) Pretzsch, nr. Merseburg, 19.vii.32, O. Michalk leg., ded., coll. E. 1035.—1 L III (hw. 2·37) Berlin-Gross-Lichterfelde, 18.iv.36, in poor soil of meadow, R. Korschefsky leg., ded., coll. E. 1794.—1 L I (hw. 1·29) Heligoland, viii.20, coll. E. 348.—1 L III (hw. 2·3) France: Versailles, 1931, L. Mesnil leg., ded., coll. E. 840.—1 exuv. III (hw. 2·18) same data, coll. E. 1012.—2 L II (hw. 1·4) Ile d'Yeu, Vendée, ix.35, R. Paulian leg., M.P.—*H.* (*H.*) *indicola* Bates, *see* Gardner, 1938, *Indian Forest Rec.* (n.s.) (*Ent.*) **3**: 150.—*H.* (*H.*) spp. 2 L III (hw. 2·96–3·0) Germany: Klingenberg on Main, 4.iii.38, in garden, W. Döhler leg., ded., coll. E. 2908.—1 L (hw. 1·37) Prödel, nr. Leipzig, 2.x.19, coll. E. 273. This specimen has a fine anterior keel on the tergites, but the seta of the basal joint of the labial palpi excludes it from the Anisodactylina.

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[34] The auxiliary tooth is present in larvae of *H. rubripes* recently reared from the egg. The eggs were deposited by a female which was collected for me, while this paper was in the press, with other living CARABIDAE by Mr. S. Croft.

Agonoderus lineola Fabricius. 5 L II (hw. 1·05–1·15–1·24), 13 L III (hw. 1.56–1·64–1·78) U.S.A.: Chevy Chacas Lake, Maryland, 30.vii.21, on golf-course putting-greens, H. S. Barber, M.W.

Bradycellus (*Stenocellus*) *rupestris* Say. 1 exuv. III (hw. 0·6), 1 I. U.S.A.: Anna, Ill., 3.vi.37, in soil of peach orchard, adult emerged 22.vi.37, M.W.

Stenolophus teutonus Schrank. 1 L III (hw. 1·05), 1 L III without head, 1 P., Denmark, M.C. The material is marked " S." and was used by Schiödte for his description. The head is loose, and the nasale has been cut off and perhaps kept on a slide. Of the other head only a fragment of one parietale is present. The tube contains two other larvae, one (evidently parasitised) belongs to *Amara* sp., the other probably to the same genus, but it has been crippled by a parasite. The material has, moreover, apparently suffered from being exposed to sunlight.—*S.* sp. ? 4 L I (hw. 0·52–0·54–0·56), 4 L II (hw. 0·75–0·77–0·80) France: Ile d'Yeu, Vendée, 30.vii.37, mare près du grand Phare, R. Paulian, M.P.—1 L II (hw. 0·78) same data, ix., M.P.—1 L II (hw. 0·8) same data, 3.ix.37, M.P.—1 L III (hw. 1·08) same data, viii.37, M.P. The first and second stages have the head-capsule narrowed to base, but the other characters as *Acupalpus*.

Acupalpus exiguus Dejean. 1 L I, 1 L I on slide (hw. 0·3) Germany: adults Gundorf, nr. Leipzig, L hatched ex ovo 29.iv. and 4.v.22, coll. E. 2549.

Chlaenius (pars a) *nigricornis* Fabricius. 1 L III (hw. 1·29) C. Europe, Verhoeff, B.M.—?1 L II (hw. 0·94) G. Britain: Charmouth, vii.20, K. G. Blair leg., B.M.—*C.* (pars a) spp. 1 L (hw. 1·26) Britain ?, B.M.—1 L (hw. 1·24) Germany: Seeburg, Mansfelder Seekreis, 12.vi.21, under stone, H. Dietze leg., ded., coll. E. 385.—1 L (hw. 0·87) Doberschützer Moor, nr. Eilenburg, 1.vii.18, from *Sphagnum*, coll. E. 160.—1 L I (hw. 0·94) Morocco: Ht. Atlas, Inri n'Ouaba, 2000 m., 9.ix.38, Paulian et Villiers leg., M.P.—1 L (hw. 2·02) China: Gan Chouen, Hin y fou et Loyang, P. Cavalerie leg., M.P.—1 L (hw. 1·64) Sta. Catharina: Nova Teutonia, 27° S. lat., 52–53° long., F. Plaumann leg., ded., coll. E. 2218.—1 L (hw. 1·5) Tanganyika: Ukerewe Is., Lake

Victoria, A. Conrads leg., ded., coll. E. 2168.—1 L (hw. 1·5) same data, coll. E. 2024.—12 L (several species) same data, coll. E. 2924.—1 L (hw. 2·09) Abyssinia : bords Riv. Antou ? (Ousné des Cartes), affluent gauche de l'Omo, 900 m., Mission du Bourg de Bozas, L. Didier leg., M.P.—1 L I (hw. 0·72) Damraou, Mission Chari-Tchad, 25.vi.03, J. Decorse leg., M.P.—*C.* (*Chlaeniellus*) *vestitus* Paykull, *nitidulus* Schrank, *nigricornis* Fabricius, *leucoscelis* Chevrolat, *impunctifrons* Say, *rayotus* Bates, *laetiusculus* Chaudoir belong to pars a, according to the descriptions by Schiödte, Schaupp, Claassen (1919, *Ann. ent. Soc. Amer.* **12** : 95), Gardner, Raynaud (1935, *Misc. ent.* **36** : (17–31)), and Boldori (1940, *Mem. Soc. ent. ital.* **18** : 283). The larva described as *fulgidicollis* Duftschmid by Xambeu (1894) is hardly a *Chlaenius*, but probably a Pterostichine larva.—*C.* (pars b) *festivus* Panzer ? 1 L III (hw. 2·14) Austria : Eastern shore of Neusiedler See, 30.vii.07, Ebner leg., Fulmek ded., coll. E. 1900.—*C. sericeus* Forster ? 2 L III (hw. 1·84–1·91) U.S.A. : Milwaukee, Wisc., 22.viii.37, Harry van Emden leg., ded., coll. E. 2978.—*C.* (pars b) spp. 2 L I (hw. 0·86–0·92) same data, 3.vii.37, coll. E. 2982.—1 L I (hw. 0·91), 1 L II (hw. 1·43) Sud tunisien et algérien, Bouvier leg., M.P.—1 L I (hw. 0·92), 1 L II (hw. 1·28) Tanganyika : Ukerewe Is., Lake Victoria, A. Conrads leg., ded., coll. E. 2927.—1 L (hw. 3·0) same data, coll. E. 2919. The latter specimen is a most remarkable larva with the sclerites pale testaceous with piceous spotlets. It suggests an isolated group.—1 L (hw. 3·9) Madagascar : nr. Sakarami, M. de Rothschild leg., 1905, M.P. Very similar to E. 2919.—The following larvae, described by various authors, belong to section b : *velutinus* Duftschmid (Raynaud 1935 ; differing from *festivus* ? by the whitish lateral quarter of the second to fourth tergites), *auripilis* Andrewes (Gardner 1936), *punctatostriatus* Chaudoir (Gardner 1938), *sericeus* Forster, *laticollis* Say, (*Chlaenites*) *circumdatus* Brullé (Gardner 1938), (*Epomis*) *circumscriptus* Duftschmid (Boldori 1940). In all the adults of *Chlaenius* pars a the basal margin of the elytra joins the side margin in a curved line, but the same condition is found in *punctatostriatus*, whereas in all the other species of pars b the two margins meet in an angle.

Rhopalopalpus janthinus Redtenbacher, *see* Gardner 1931, *Indian Forest Rec. Ent.* **16** : 93.

Callistomimus chalcocephalus Wiedemann, *see* Gardner, 1936, *loc. cit.* (n.s.) (*Ent.*) **2** : 188.

Oodes helopioides Fabricius. 3 L III (hw. 1·2–1·28) Denmark : Fürsö, 14.viii.02, in rubbish at edge of water, E. Rosenberg leg., det., ded., coll. E. 189.—1 L III (hw. 1·28) Germany : Stotternheim, Thuringia, 18.vii.24, K. Dorn leg., ded., coll. E. 2507.—2 L III (hw. 1·2–1·24) Walkenried, S. Harz Mts., 1.viii.20, K. Dorn leg., ded., coll. E. 202.

Rembus laticollis Leconte. 1 exuv. III (hw. *c.* 1·1), 1 I. U.S.A., coll. Hamilton, M.W.—1 L III (hw. 1·2) Milwaukee, Wisc., 15.viii.37, Harry van Emden leg., ded., coll. E. 2977.

Dicaelus purpuratus Bonelli. 1 L III (hw. 2·3) U.S.A. : New Orleans, Sallé leg., B.M. Obviously the specimen described by Candèze.—*D.* sp. 1 L California ?, M.P.

Licinus punctulatus Fabricius. 1 L III (hw. 1·26) France : Hyères, v.21, K. G. Blair leg., Emd. det., B.M.—1 L II (hw. 0·94 ; width of metanotum 2·44 mm.). Morocco : O. Judios, Vallée moyenne et Colline de la rive droite, 1901, G. Buchet leg., M.P.—1 L II (hw. 0·94 ; width of metanotum 2·62 mm.) Sidi-Ali, nr. Azemmour, Mission du Gast, M.P.—2 L III (hw. 1·15–1·19) Algeria : Arzeu, iv.88, Brölemann leg., M.P.—1 L I (hw. 0·94 ; width of metanotum 1·67 mm.) France : St. Raphael, Var, iv.38, Guy Colas leg., M.P.—*L. depressus* Paykull. 1 L III ? on slide (hw. 0·84) Germany : Lochham, nr. Pasing (Munich), 15.vi.21, Verhoeff, B.M.—*L.* sp. 1 L on slide (hw. 1·13) Italy : Loreto, nr. Ancona, 17.iv.25, Verhoeff, B.M.

Dilonchus bidens Andrewes, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2** : 181, 186.

Trichisia morio Laferté, *see* Gardner, 1927, *Indian Forest Rec., Ent.* **13** : 66; 1936, *loc. cit.* (n.s.) (*Ent.*) **2** : 182.

Panagaeus crux major L. 1 L III (hw. 0·88) in process of pupating, Denmark : Alleröd, 30.vii.36, Rosenberg leg., det., ded., coll. E. 2286.—1 L III on slide (hw. *c.* 0·81) Denmark, Verhoeff, B.M.—*P.* sp. 1 exuv. III (hw. 0·88) Channel Islands, W. E. China leg., ded., B.M.

Craspedophorus (and related genera) spp. 1 L (hw. 1·42) Tanganyika : Ukerewe Is., Lake Victoria, A. Conrads leg., ded., coll. E. 2023.—1 L I dry (hw. 1·1) Sierra Leone : Njala, 1.vi.26, E. Hargreaves leg., B.M.—1 L (hw. 1·54) Hongkong, J. C. Bowring, B.M. (specimen incomplete).—The third and fourth antennal joints are only present in the larva from Ukerewe. In my former key I reported the antennae to be three-jointed with a minute fourth joint, according to Coquerel. I am now satisfied that the so-called fourth joint was in reality the appendix of the third, and that the real fourth joint was lost in Coquerel's larva.

Tefflus sp., *see* Burgeon, 1934, *Bull. Ann. Soc. ent. Belg.* **74** : 189.—*T. juvenilis muansanus* Kolbe ? 3 L I (hw. 2·19–2·21–2·23), 1 L II (hw. 3·0), 5 L III (hw. 3·8–3·85–3·9 mm.) Tanganyika : Ukerewe Is., Lake Victoria, A. Conrads leg., ded., coll. E. 2919, 2169, 2022. Besides this form *T. zanzibaricus gogonicus* Kolbe has been collected by Father Conrads, but it is still larger, and, therefore, the larvae are assumed to be rather *muansanus.*—*T. corpulentus* Sternberg ? 1 L II (hw. 4·7) Belg. Congo : Ubangi, Libenge, i.30, H. J. Bredo leg., Congo Mus. ded., Emd. det., coll. E. 1997.—*T.* sp. 1 L I (hw. 2·6) Mozambique : Guengère, 13.xii.05, G. Vasse, M.P.

Anaulacus fasciatus Schmidt-Goebel. 3 L I (hw. 0·50–0·51–0·52), 1 L II (hw. 0·65), 2 L III (hw. 0·91–0·94) India : Batu Caves, Selangor, 20–23.xi.26, in the Dark Cave, 600–1200 ft. from entrance, C. Dover leg., B.M. *See* Blair, 1929, *J.F.M.S. Mus.* **14** : 385.

Masoreus orientalis Dejean, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2** : 197. I have seen a mounted specimen and made the following notes supplementary to Gardner's description : fourth antennal joint hardly shorter than third, joints of outer lobe subequal, second joint of maxillary palpi (third, if palpiger included) only half as long as the last joint, tarsi and tibiae without setae except for the apical ones.

Tetragonoderus elegans Andrewes, *see* Gardner, 1938, *Indian Forest Rec.* (n.s.) (*Ent.*) **3** : 154.

Zuphiini ? genus indet. 1 L II or III (hw. 1·01) French Guinea : Kouroussia, viii.37, L. Berland leg., M.P. Obviously a very isolated type of Truncatipennes. There is hardly an isolated group unknown, occurring in W. Africa, but the Zuphiini, of which the two genera *Eunostus* and *Zuphium* are possible.

Genus indet. 4 (*Eurycoleus* ?). 1 L II or III (hw. 1·47) Venezuela, Geay leg., M.P.

Coptodera interrupta Schmidt-Goebel, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2** : 193, 194. I have seen one of Mr. Gardner's slides, from which I made the following notes : the penicillus is not distinguishable, but apparently broken, ligula absent, but the setae well developed; abdominal tergites not margined; anal segment conical, without crotchets; tarsi and tibiae as in *Mochtherus*; the apical part of the cerci distinctly separated as a segment, the two preceding parts incompletely separated, fixed at one side as in *Agonum.*

Thyreopterus sp.? 1 L II (hw. 0·94), 4 L III (hw. 1·20–1·24–1·27) Ivory Coast: Haut Cavally, Ch. van Cassel leg., M.P. Characters of the Coptoderina, which are represented at the Ivory Coast by *Thyreopterus* (incl. *Thyreopterinus*), *Catascopus* and *Coptodera.* As the larva of an Oriental *Coptodera* is known and it is considerably different, and since the following larva but two is assumed to be *Catascopus* (p. 78), it is probable that the present larvae, which must belong to a species of which the adult is approximately 7·5–8·5 mm., are *Thyreopterus* or its subgenus *Thyreopterinus* Alluaud. As the base of the seta that represents the inner lobe forms a small tubercle, this might also be one of the genera transitional between Anchomenina and Truncatipennes, perhaps *Colpodes* or a related genus.

Mochtherus tetraspilotus McLeay, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2**: 193. The slide, which I was able to study by courtesy of Mr. Gardner, shows that: the abdominal tergites are not margined, each crotchet is about half as long as the tenth abdominal segment is wide, the tarsi and tibiae are without ventral bristles, only a whorl at apex of tibia and a pair of dorsal setae at apex of tarsus being present, the claws are very unequal, the cerci distinctly quite unjointed.

Lobodontus trisignatus Chaudoir? 2 L III? (hw. 1·13–1·20) Tanganyika: Ukerewe Is., L. Victoria, A. Conrads leg., ded., coll. E. 2170. These larvae may belong either to *Lobodontus*, of which only one species has been found on Ukerewe, or to another type of *Catascopus*, but the size would best fit the former, the adult of which is 7·5 mm. long. The only other genera of Coptoderina found by Father Conrads are *Thyreopterus* (incl. *Thyreopterinus*) and *Coptodera.*

Catascopus sp.? 1 L III (hw. 2·3) Tonkin: Upper reaches of river Claire, J. de Retz leg., M.P. This larva must belong to the Coptoderina, and the size of the adult must be above 13 mm. As far as I am aware, the large species of *Catascopus* of this region are the only Coptoderina of this size, of which the larvae are unknown, and which reach so far to the north-east of the Oriental region.

Cymindis humeralis Fourcroy. 6 L I, 1 on slide (hw. 0·56–0·57–0·58) Verhoeff, B.M.—*C. angularis* Gyllenhal. Some unpublished drawings by Mr. E. C. Rosenberg of Copenhagen.—*C.* sp. 1 L II? on slide (hw. 0·77) Poland: Warsaw, 25.x.25, Makolski leg., Netolitzky ded., coll. E.

Cymindoidea indica Schmidt-Goebel, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2**: 196.

Arsinoë grandis Péringuey. 2 L II? (hw. 1·12) Tanganyika, with the prey: L of *Catamerus revoili* Fairmaire, B.M.—1 L I (hw. 0·73) 5 L II? (hw. 1·13) on slides, Nyasaland, C. Smee leg., B.M. *See* Blair, 1927, *Proc. ent Soc. Lond.* **1**: 58, 60. *Arsinoë* is an isolated genus within the Lebiini, in the adult as well as in the larval stage, and is included in the Lebiina as an aberrant genus of this subtribe.

Lebia scapularis Fourcroy. 3 L I (hw. 0·3), 2 P., cocoons 1 I. France: Vienne, Dauphiné, 20.vii.21, L. Falcoz leg., B.M.—*L. chlorocephala* Hoffmann. L I (hw. *c.* 0·55), *see* Rosenberg, 1903, *Ent. Meddel.* (2) **2**: 9.

Onota floridana Horn. 1 L II (hw. 0·60), 1 L III (hw. 0·90) U.S.A.: Punta Gorda, Fla., 14.vii.94, with adults beaten from Palmeiro fans, M.W. The cerci of these larvae are broken, and I cannot trace the crotchets of the tenth abdominal segment. The colour is entirely pale, the seta of the first joint of the outer lobe does not very far exceed the apex of the second joint, retinaculum wholly absent.—*O. angulicollis* Reiche or *Otoglossa* sp.? 1 L I (hw. 0·51) Costa Rica: Reventazon, Hamburg Farm, 30.i.36, on withered leaf, F. Nevermann leg., ded., coll. E. 2831. Cerci (fig. 81) three- or four-jointed, only the first articulation more distinct, crotchets distinct. Colour of the sclerites dark brown, but apical half of cerci whitish. Seta of the first joint of the outer lobe longer, a minute, appressed retinaculum present (fig. 57).

Plochionus pallens Fabricius. 4 L II (hw. 0·67–0·79), 1 L III (hw. 1·09) from Mexico: Tehuacan, Pueb., 2.xii.36, imported in Laredo, Tex., U.S.A., on dry garlic, M.W.—1 L II (hw. 0·75) same data, 12.vi.37, M.W.—*P. timidus* Haldeman. 3 L II (hw. 0·71–0·77), 2 L III (hw. 1·05–1·13) U.S.A.: Kirkwood, Mo., 29.vi.92, M.W.

Calleida purpurea Say. 1 exuv. II (hw. 0·94), 1 exuv. III (hw. 1·31), 1 I. U.S.A.: Rocky Ford, Color., 17.viii.15, feeding on larvae of *Ancylis comptana* Froelich, pupated 29.viii., adult emerged 5.ix., C.C. Hamilton leg., M.W.—*C. decora* Fabricius. 1 exuv. II (hw. 0·90), 1 exuv. III (hw. 1·28), 2 P. U.S.A.: Crescent City, M.W.—*C.* spp. 1 L II? (hw. 0·9) U.S.A.: Tampa, Fla., iv.76, Schwarz leg., M.W.—1 L II? (hw. 0·96) Costa Rica: Guapiles, 24.vi.35, on shrub, F. Nevermann leg., ded., coll. E. 2734.—*See* Gardner, cited under *Parena*.

Andrewesella trivittata Leconte. 1 L III? (hw. 0·71), 2 I. U.S.A.: Key West, Fla., 15.iii.92, feeds on young Tingid (*Corythuca gossypii*), E. A. Schwarz leg., M.W.

Parena nigrolineata Chaudoir, *see* Gardner, 1933, *Indian Forest Rec., Ent.*, **17** (8): 11.

Dromius agilis L. 1 L III (hw. 0·77) Denmark: Damhusmosen, nr. Copenhagen, 9.vii.05, under bark of willow, Kryger leg., M.C.—*D. quadrimaculatus* L. 3 L III (hw. 0·66–0·71–0·75) Denmark: Tisvilde Hegn, 17.iv.30, Sv. G. Larsson, M.C.—*D. linearis* Olivier? 1 L III (hw. 0·52) Branscombe, iv.35, K. G. Blair leg., B.M.—*D. eremnus* Andrewes, *see* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2**: 195.—*D.* sp. 1 L III (hw. 0·58) Beer, S. Devon, iv.30, K. G. Blair leg., B.M.—*D.* sp.? 1 L II or III (hw. 0·43) Germany: Hamburg-Horn, on main branch of apple-tree, Titschack leg., Mus. Hamburg. I identified this larva some years ago as *Metabletus* or *Microlestes* sp. and made drawings of it. It has no trace of cerci and only a minute tooth on the claws; no egg-bursters are present; the size of the adult must be about 3·9 mm. or 2·7 mm. As a larva of *Metabletus* has since been described, and as the other characters and the habitat are those of *Dromius*, I think now that this is one of the smaller species of that genus.

Risophilus atricapillus L. 1 L II (hw. 0·51), 1 L III (hw. 0·65) Denmark: Stengade, Langel., 9.viii.96, W. Schlick leg., M.C.—1 L II (hw. 0·51), 1 L III (hw. 0·69) Reigate, 3.vii.73, B.M.—1 L III (hw. 0·70) Ottery St. Mary, Devon, vii.35, S. Turpin leg., B.M.—1 L III (hw. 0·68) France: Lampaul-Plouarzel, Finistère, 12–14.vii.37, in garden Le Créach, G. Lemasne leg., M.P.—None of these larvae has crotchets on the anal tubes, which are said by Böving (1931, *Ent. amer.* (n.s.) **11**: 19) to be present in *Demetrias*.

Metabletus cymindulus Bates. 1 L III on slide (hw. 0·56) India: Almorah, U.P., in soil, J. C. M. Gardner leg., det., ded., B.M. *See* Gardner, 1936, *Indian Forest Rec.* (n.s.) (*Ent.*) **2**: 195.

Oecornis nidicola Britton (1940, *Ent. mon. Mag.* **76**: 110). 7 L I (hw. 0·39–0·40–0·42), 5 L II (hw. 0·57–0·58–0·60), 3 L III (hw. 0·74–0·80–0·83)

Tanganyika: Amani, i.37, in nest of hornbill (*Bycanistes cristatus* Rüppell), R. E. Moreau leg., B.M.

Odacantha melanura Paykull. L III (hw. *c.* 0·9) *see* Rosenberg, 1903, *Ent. Meddel.* (2) **2**: 1–21, t. 1, f. 1–8.

Leptotrachelus dorsalis Fabricius. 1 L III (hw. 0·84), 1 P., 1 I. U.S.A.: Oxford, Indiana, 19.viii.84, F. M. Webster leg., M.W.—A larva with similar characters but a more developed inner lobe (hw. 1·31) from Kashmir: Gulmarg, 1931, in fungus, M. Cameron leg., is in B.M. This may belong to a genus of Colliurini or one of Anchomenina transitional towards the former group.

Drypta dentata Rossi. 1 L III (hw. 1·27) France: Parc de Versailles, in decomposing hay, vii.29, L. Mesnil, coll. E. 3005. 1 L III (hw. 1·27) France: Plouarzel, Finistère, 17.viii.37, running on the ground, G. Lemasne leg., M.P. I obtained the first of these larvae from my friend, M. L. Mesnil, who, together with F. Pétré, described it as that of *Pterostichus strenuus* Panzer (1931, *Bull. Soc. ent. France* **1930**: 324). This is an interesting instance of the fact that even breeding may result in misidentification, unless each larva is bred individually. Apparently a larva of *Pterostichus* was among those captured, or in the soil, etc., and happened to transform first or alone. The larva described by Mesnil could ex systemate and patria only be that of *Drypta* or *Polystichus*, and the close relationship with the known larvae of *Galerita* would suggest the former identification. This was confirmed with certainty, when I obtained through the kindness of Father Conrads the following almost identical larva from Ukerewe, where *Polystichus* does not occur, whereas several species of *Drypta* are quite common.—*D.* sp. 1 L III (hw. 1·15) Tanganyika: Ukerewe Is., L. Victoria, A. Conrads leg., ded., coll. E. 2925.

Desera australis Péringuey? 1 L II (hw. 0·75), 2 L III (hw. 1·05) Tanganyika: Ukerewe Is., L. Victoria, A. Conrads leg., ded., coll. E. 2925. These larvae may either be another species of *Drypta* or *Desera* sp., but I should not expect the species of *Drypta* to differ so much and consider *Desera* more probable, though I have seen only a single adult (*D. australis*) from Ukerewe, whereas several species of *Drypta* are common on the island.

Galerita lecontei Dejean. 1 L III (hw. 2·30), 1 I. U.S.A.: New Orleans, Sallé, B.M. 65–54.—*G. nigra* Chevrolat. 1 L III (hw. 2·62) Mexico, Sallé leg., B.M. 65–54. This is no doubt the specimen described by Candèze (1861, *Mém. Soc. R. Sci. Liège* **16**: 327) as number 54 of 1865 in the accession-register of the B.M. includes practically all the American species described in Candèze's paper of 1861. The specimens were bought by the B.M. from Sallé.—*G. simplex* Chaudoir. 1 L III (hw. 1·92) Mexico, B.M. 65–54. Obviously the specimen described by Candèze, *loc. cit.*: 329.—*G.* spp. 1 L dry (hw. 1·85) Brazil: Tapajoz, Bates leg., B.M.—1 L III (hw. 2·51) S. Catharina: Nova Teutonia, 27° lat., 52–53° long., F. Plaumann leg., ded., coll. E. 2142.—1 L II (hw. 1·40) Costa Rica: Reventazon, Hamburg Farm, 25.xi.36, near nest of *Eciton*, F. Nevermann leg., ded., coll. E. 2972. This specimen is even smaller than the following one from N. Rhodesia, but it has no egg-bursters, and the cerci are 11-jointed, including base. As some of the African species are much larger and stouter, there is no doubt that this Costa Rica specimen must be the second stage in spite of the smaller size.—1 L I dry (hw. 1·67) N. Rhodesia: Kipushi, 8.ii.28, active runner, S. Evans leg., ded., B.M. Differs from all the others seen by having only three very long segments besides the long, fixed basal part of the cerci. This may be a character of the first stage (most likely) or of the first stage of the African species, or perhaps even of all the stages of the African species.

Mormolyce phyllodes Hagenbach. 1 L II? (hw. 3·45) Borneo: Sarawak, R. Shelford leg., det., ded., M.C. The discrepancies between this larva and Verhuell's description (on which I had to rely in my earlier key) are very great, though the mandible and labium figured by Verhuell are similar to those of the present larva.

Omphra sp. 2 L (hw. 1·85) S. India: Coimbatore, 1911, Cecil S. C. Fisher, B.M.—*O. atrata* Klug, *see* Gardner, 1933, *Indian Forest Rec., Ent.* **17** (8): 4.

Triaenogenius sculpturatus Gerstäcker? 8 L Tanganyika: Ukerewe Is., Lake Victoria, A. Conrads leg., ded., coll. E. 2923. *T. sculpturatus* is the only common species of this group on Ukerewe, the other forms belonging to *Macrocheilus* and being rare. Father Conrads therefore believes that this cannot be the latter but must be *T. sculpturatus.* The head-widths of the larvae are 1·07 (1 larva), 1·26–1·35 (3) and 1·73–1·78 (4), the factors of growth being 1·21 and 1·35. If the species has three larval stages as in other CARABIDAE, the adult would measure about 11–13 mm. and fit some East African *Macrocheilus*, whereas *Triaenogenius* is of twice that size. On the other hand, the larvae would seem to be generically distinct from *Macrocheilus niger.* As the smallest larva has no egg-bursters, it may be possible that this strange group of CARABIDAE has more than three larval stages and that my material does not contain either the first or the last stage. In the smallest larva the eighth abdominal segment is black, whereas it is pale in the other larvae, the vestigial second joint of the cerci is proportionately twice as long as in the larger larvae.

Macrocheilus niger Andrewes and *Colfax stevensi* Andrewes, *see* Gardner, 1933, *Indian Forest Rec., Ent.* **17** (8): 4–6, where the known larvae of Helluonini are tabulated, the present key to this tribe being largely based on that of Gardner. The larva described by Schaum as that of *Creagris labrosa* Nietner (= *Acanthogenius piceus* Schaum) does certainly not belong to this group, the description and figures are, however, too inadequate to permit the genus or tribe to be recognised.

Eccoptoptera mutilloides mela Strohmeyer? 1 L I (hw. 1·54) Ukerewe, A. Conrads leg., ded., coll. E. 2922. Father Conrads has collected the following adults of Anthiini on Ukerewe: *Anthia massilicata stygne* Kolbe (length 35–42 mm.), *Eccoptoptera cupricollis ukerewensis* Strohmeyer (16–16·5 mm.; acc. to Strohmeyer: 14 mm.), *E. mutilloides mela* Strohmeyer (19 mm.; Strohmeyer: 17–19·5 mm.), *Polyhirma caillaudi ukerewensis* Kuntzen (26–28 mm.; Strohmeyer: 22–28 mm.), *P. trilunata insulana* Strohmeyer (19–22 mm.; Strohmeyer: up to 25 mm.), *P. gracilis hemiraphis* Strohmeyer (common, 14·5–18 mm.; Strohmeyer: 17 mm.), and *P. elegantula conradsi* Sternberg (16 mm.; Strohmeyer: ♂ 14–16, ♀ 16–17 mm.). There can thus be no doubt about the identification of the *Anthia*, which is common on Ukerewe, and hardly any about the larger larvae with elongate head and short cerci, which must, according to their head-width, belong to an adult of about 24–29 mm. length, *i.e. Polyhirma caillaudi ukerewensis.* The other two species of larvae certainly belong to two genera, and the smaller one, which indicates an adult of about 13 mm. or a very slender adult of slightly larger size, is obviously more closely related to *Polyhirma ukerewensis* than the present species and may be *P. gracilis hemiraphis,* these two being, by the way, the two more common species of *Polyhirma* on Ukerewe. Therefore, it may be assumed that larva 2922, indicating an adult of 18–19 mm., belongs to the larger species of *Eccoptoptera,* which is common on Ukerewe. Its more striking characters, besides those mentioned in the key, are: head orange, first two abdominal segments yellowish orange, tenth abdominal segment, mouth-parts, legs, except coxae, and cerci, except base, brownish orange, the rest black to piceous.—*E.* sp. 1 L I dry (hw. 2·0) Nyasaland, J. E. S. Old, B.M. Very similar, but cerci distinctly longer than head.

Polyhirma gracilis hemiraphis Strohmeyer? 1 L I (hw. 1·1), 1 L II (hw. 1·44) Ukerewe, A. Conrads leg., ded., coll. E. 2967. Concerning the identification see *Eccoptoptera.* Epipleurites simple, slightly convex, the setae not very dense nor strong. Sclerites of eighth abdominal segment free. Head, prothorax and the first two abdominal segments orange, the head somewhat more reddish, the two abdominal segments more yellowish, mouth-parts and tips of legs more brownish, the other sclerites piceous, cerci and tenth segment somewhat yellowish towards apex. Posterior claw of each tarsus more than half as long as the anterior one.—*P. caillaudi ukerewensis* Kuntzen? 8 L I (hw. 2·0–2·3) Ukerewe, A. Conrads leg., ded., coll. E. 2167, 2921. Epipleurites bluntly coniform and strongly setose. Sternum and sternella of eighth abdominal segment fused. Head reddish piceous, antennae, mouth-parts and legs brown (but fore coxae orange), pronotum reddish-brown, first two abdominal segments yellowish orange, tenth segment brownish orange, the other sclerites piceous. Posterior claw of each tarsus a third as long as anterior one. For a photograph *see* Boldori, 1940, *Miss. biol. Paese Borana Zool.* 2 (1) : (9), fig. 2.—*P.* sp.? 2 L I (hw. 2·55) Dakar, ix.33, under stone, L. Berland leg., M.P. Like the following, only slightly paler.—1 L I (hw. 2·5) Niger-Tchad, Tibiri-Maradi, Mission Tilho, vii.–viii.07, R. Gaillard leg., M.P. The shape of the head and the fused ventral sclerites of the eighth abdominal segment as in *P. caillaudi*, but the other characters are as in *Anthia.*

Anthia massilicata stygne Kolbe. 7 L I (hw. 3–3·2), 1 L II (hw. 3·9), 2 L III (hw. 5·3–5·4) Ukerewe, A. Conrads leg., ded., coll. E. 2167, 2920. Concerning the identification see *Eccoptoptera.* The head-width suggests an adult of about 36 mm. or more; my beetles from Ukerewe are 35 and 42 mm. long. Head and cerci piceous-red, meso- and metanotum and seventh and eighth abdominal segments orange. For a photograph *see* Boldori, 1940, *Miss. biol. Paese Borana Zool.* 2 (1) : (7) fig. 2, (9) fig. 1. The posterior claw of each tarsus is extremely small and closely appressed to the anterior one, so that apparently only one claw exists. Cerci rather blunt in shape, suddenly constricted and pointed, in the second and third stages they are clothed between the setae with rather dense, short, fine, erect hairs.—*A. massilicata* subsp.? 1 L I (hw. 2·7) Tanganyika: Iringa, coll. E. 2547. Very closely related and probably conspecific. 1 L I (hw. 2·9) Nyasaland, Sandy coll., B.M. Also very similar.—*A. decemguttata* L.? 1 L III (hw. 4·5) S. Africa : Willowmore, H. Brauns leg., ded., coll. E. 2548. Similar to *stygne*, but in addition to the meso- and metanotum the sixth to eighth abdominal segments are orange, cerci clothed with very unequal strong setae, among which on the apical half numerous fine, rather long setae are found, gradually tapering, suddenly somewhat constricted at apex and ending in a rather stout point.—*A. crudelis* Harold? 1 L I (hw. 4·1) Belg. Congo : Kinda, 2.xii.14, L. Charliers leg., Mus. Congo Belge, Tervueren (*see* Emden, 1937, *Ent. mon. Mag.* **73** : 58). The first stage is 17 mm. long, and the head-width indicates an adult of about 49 mm. *A. crudelis*, an identification which M. L. Burgeon suggested, measures 40–50 mm., according to Harold. Piceous-black, only the middle part of the meso- and metanotum broadly brownish-yellow (approximately on half the width and the entire length of these segments). Cerci and tenth abdominal segment ferruginous. Setae piceous, rufous towards apex of abdomen.—*A.* spp. 1 L I (hw. 2·79) Tourkouana-land, 640–1010 m., Mission du Bourg du Bozas, L. Didier leg., M.P.—1 L I (hw. 2·7) Nyasaland: Mlanje, i.–ii.14, J. B. Duvey leg., B.M. Coloration as *stygne*, cerci rather slender, somewhat incurved, shining, setae rather sparse but very long, apical point rather long and well defined.—1 L III (hw. 6·8) Upper Zambezi, Lenlui district, 1919, V. Ellenberger leg., M.P.—1 L II (hw. 3·9) Upper Dahomey: Cercle D'ougon-Kouandi, Lt. Brot leg., M.P.—*A. duodecimguttata* Bonelli. 1 L II (hw. 3·2) Arabia: Hafair, 10.viii.34, H. St. J. B. Philby, B.M. Uniformly piceous, with only the head and pronotum piceous-red, cerci somewhat shining, rather short, strongly tapering, but distinctly constricted at apex with a set-off point, setae rather sparse and very long. Posterior claw of each leg more than half as long as the anterior one. This character separates from the other species the present form and—*A. sexmaculata* Fabricius. *See* Chopard, 1936, *Bull. Soc. ent. France* **41** : 168. Coloration the same, but cerci slenderer.—*A. sexguttata* Fabricius. 1 L II ? with egg-bursters, but probably a L II in which they have persisted (hw. 4·7), 1 L III (hw. 6·5) Kurrachee, M. Maindron, M.P. *See* Gardner, 1939, *Proc. R. ent. Soc. Lond.* (B) **8** : 18.—*A.* spp. 1 L I (hw. 2·8) S. Africa: Cape Province, Ceres, ii.32, Miss A. Mackie, B.M. Head and 6th to 8th abdominal segments dull red, dorsum black elsewhere. Cerci somewhat incurved and gradually pointed at apex, subapical constriction very weak, point rather long, cerci scabrose-punctate, setae of unequal length.—1 L I (hw. 3·1) Nyasaland, Sandy leg., B.M. Head and cerci dull red, the entire thorax and the 6th to 8th abdominal segments ferruginous, 1st to 5th segments piceous. Cerci very stout near base, gradually pointed, the subapical constriction very slight. These last two species may perhaps belong to *Anthia* s.str.

Pheropsophus hispanicus Dejean. 2 L I (hw. 0·32–0·33) adults from Terror, Gran Canaria, larvae raised by K. M. Heller, coll. E. 172. *See* Emden, 1919, *Suppl. ent.* **8** : 34–38, t. 1.—*P. africanus* Dejean. 7 L I (hw. 0·38–0·39) adults from Eritrea: Ghinda, larvae raised by L. Boldori, coll. E. *See* Boldori, 1939, *Riv. Biol. colon.* **2** : 173–183. I owe these larvae to Dr. Heller and Signor Boldori respectively. The organ described as the inner lobe by Boldori is actually a strong seta, which is not stronger than some of the stouter setae of the legs. In *hispanicus* this seta is very gently and evenly curved inward, whereas in *africanus* it is more conspicuously curved, particularly in the apical half. The difference in the size of the egg-burster pointed out by Boldori is more apparent than real, the posterior area of the egg-bursters being much less sclerotised in *hispanicus* and not correctly drawn in my figure of 1919, *see* fig. 68.

Brachinus crepitans L. 1 L on slide (hw. 0·25) from adults from Denmark, E. Rosenberg bred 10.vii.19, Rosenberg ded., coll. E.; fig. 8.

All the figures are of larvae and, except for those where no special microscope is indicated, have been drawn with a camera lucida and a Leitz microscope (L) or a Zeiss binocular microscope (Z). The first number after the microscope refers to the eye-piece, the second to the objective used (*e.g.* L 2, 3 indicates a Leitz microscope with eye-piece 2 and objective 3). The letters a, b, etc. after the objective refer to the scale drawn to the same enlargement; these scales are in mm. A dotted line indicates a part seen by transparence or, so far as projecting parts are thus drawn, a reconstruction of lost parts.

Abbreviations used in the figures.

1, 2, 3 etc.	segments of antennae, palpi or abdomen
ad	adnasale
ap	sensorial appendage
at	anal tubes
cg	cervical groove
ck	cervical keel
co	coxa
cr	crotchets
eb	egg-burster
ep	epipleurite
es	epicranial suture
fe	femur
fr	frontal piece
fs	frontal suture
hp	hypopleurite
il	inner lobe of maxilla
kn	granulose knob of cardo
lg	ligula
mt	mentum
na	nasale
ol	outer lobe of maxilla
pa	parietale
pg	palpiger
pl	labial palpi
pm	maxillary palpi
pn	penicillus of mandible
po	postventrite
pr	praeventrite
rt	retinaculum of mandible
sn	sensorium
st	stipes of maxilla
ta	tarsus
ti	tibia
tr	trochanter
vt	ventrite

Fig. 1.—*Dromius* sp.? (Hamburg.) L 3, 2, a. *a.* One epipleurite more strongly enlarged. *b.* Ventral view of the sixth to tenth abdominal segments.

Fig. 2.—*Physea setosa* Chaudoir. Scale b.

Fig. 3.—*Leistus spinibarbis* Fabricius. Dorsal view of head. L 0, 2, c.

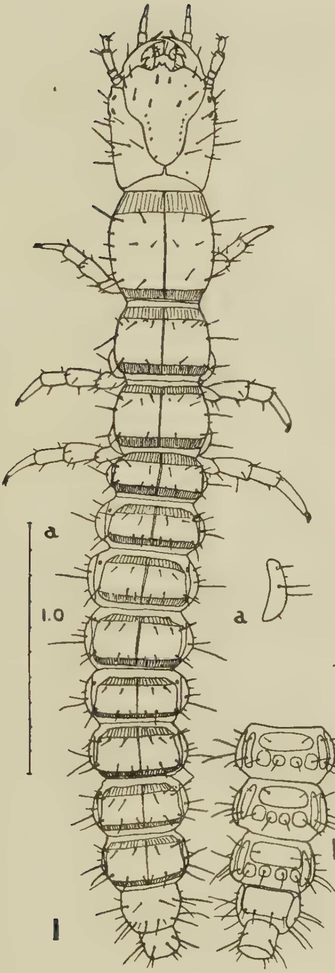
Fig. 4.—*Notiophilus biguttatus* Fabricius. L I Doberschütz. Dorsal view of head. L 2, 3, d.

Fig. 5.—*Physea setosa* Chaudoir. Dorsal view of head. L 1, 2, e. *k* transverse keel.

Fig. 6.—*Pogonus luridipennis* Germar? L III, Sülldorf. Dorsal view of head. L 0, 2, c.

Fig. 7.—*Orthogonius assmuthi* Wasmann. Dorsal view of head. Z 2, a_2, f.

Fig. 8.—*Brachinus crepitans* L. Dorsal view of head. L 4, 3, g.


a
1.0
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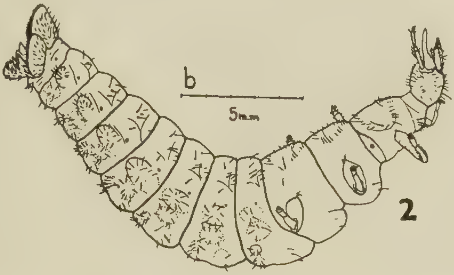
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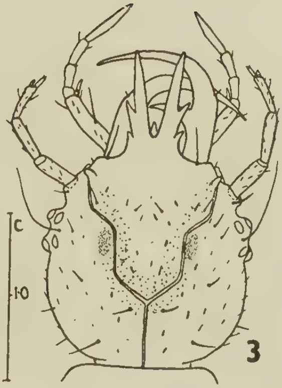
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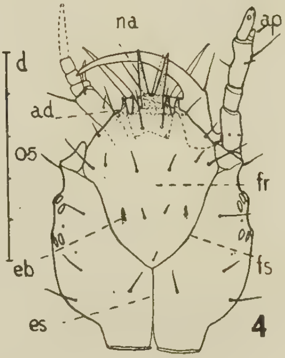
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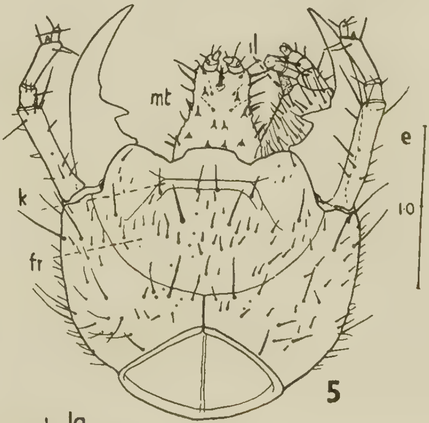
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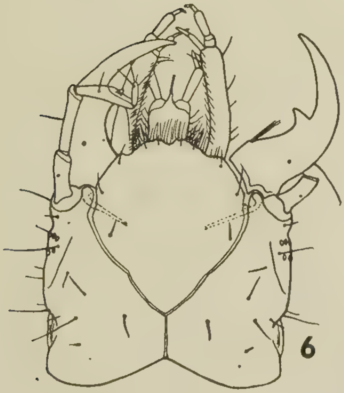

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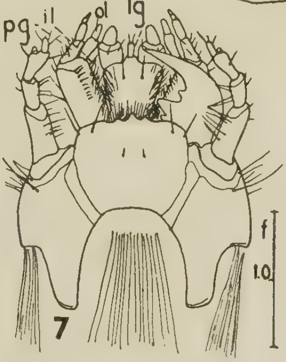
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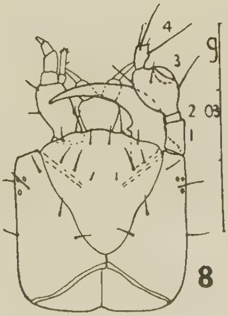
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Fig. 9.—*Scarites* (*Scaritodes*) *semicarinatus* Chaudoir. Dorsal view of head. Z 2, a_0, h.

Fig. 10.—*Amara* (*Bradytus*) *fulva* Degeer, Riesa. Dorsal view of head. L 1, 2, i.

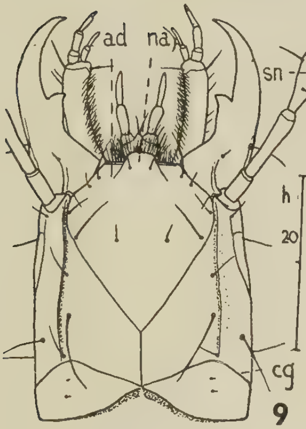
Fig. 11.—*Anisotarsus sayi* Blatchley. Dorsal view of head. L 1, 2, i.

Fig. 12.—*Amphasia interstitialis* Say. Dorsal view of head. L 0, 2, c.

Fig. 13.—*Dromius* sp. ? Hamburg. Dorsal view of head. L 4, 3, j.

Fig. 14.—*Arsinoe grandis* Péringuey. L 1, Dorsal view of head. L 1, 3, k.

Fig. 15.—*Rembus laticollis* Leconte. Milwaukee. Dorsal view of head. L 1, 2, i.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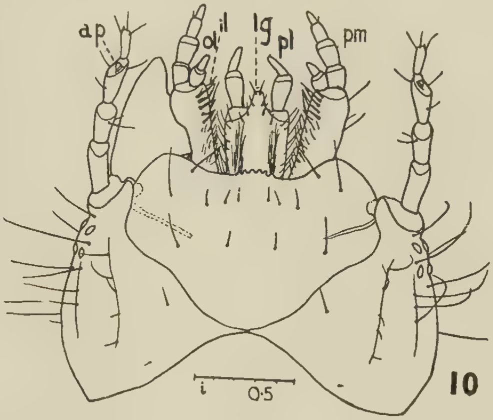
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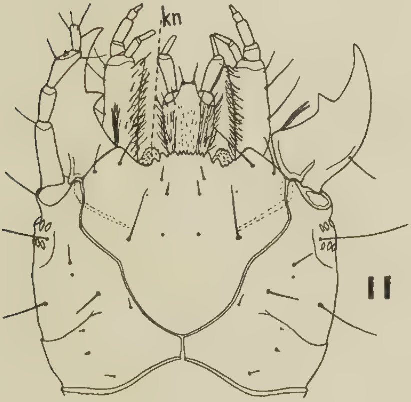

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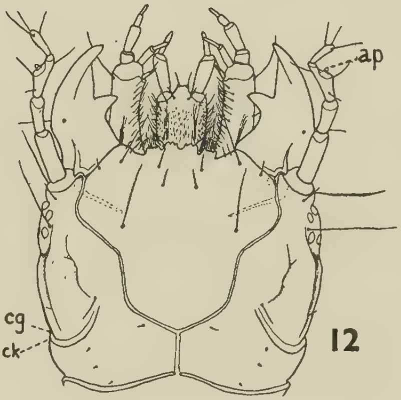

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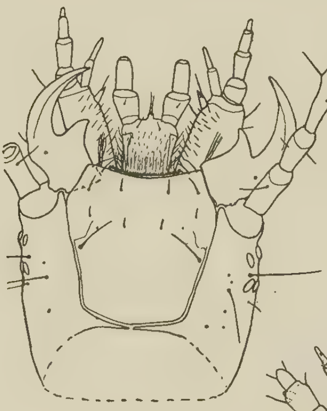

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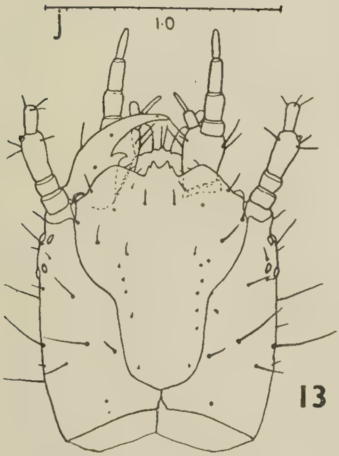

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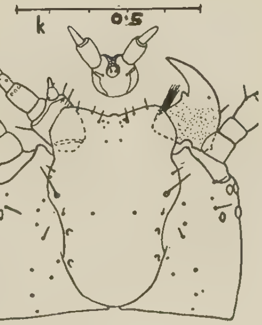

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FIG. 16.—*Eccoptoptera mutilloides mela* Strohmeyer? Dorsal view of head. Z 2, a_2, f. Left maxilla, right mandible and labial palp omitted.

FIG. 17.—*Triaenogenius sculpturatus* Gerstäcker? Dorsal view of head. Z 2, a_2, f. Left mandible omitted.

FIG. 18.—*Mormolyce phyllodes* Hagenbach. Dorsal view of head. Z 2, a_0, h.

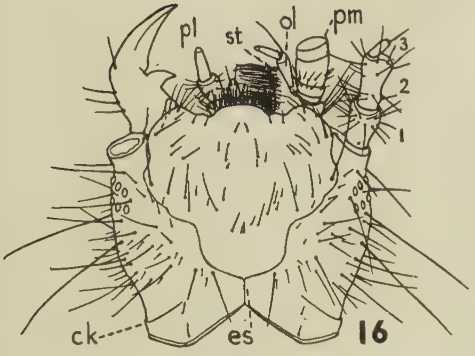
FIG. 19.—*Catascopus* sp.? Dorsal view of head. Z 2, a_2, f.

FIG. 20.—*Craspedophorus* sp. Ukerewe. Dorsal view of head. Z 2, a_2, f.

FIG. 21.—*Tefflus juvenilis muansanus* Kolbe? Dorsal view of head. Left maxilla and right labial palpus omitted. Z 2, f55.

FIG. 22.—Zuphiini gen. sp.? Dorsal view of head. L 2, 2, m. (The basal sixth of the mandible should be narrower on the dorsal surface, with only the ventral edge somewhat projecting as drawn on the right side.)

FIG. 23.—*Feronia* (*Poecilus*) *lucublanda* Say. Milwaukee. Lateral view of head. *b* elongate swelling. L 1, 2, i.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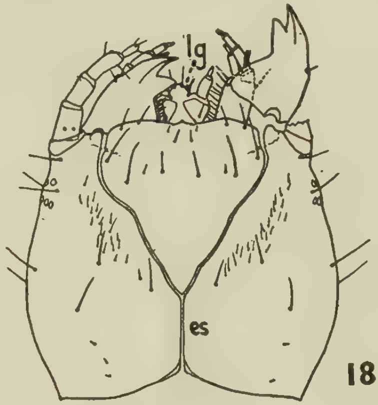

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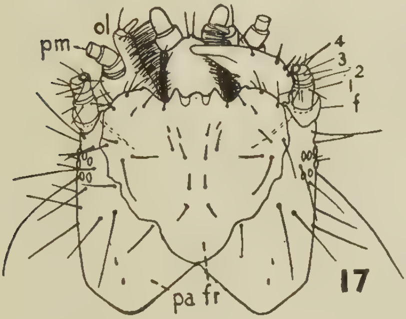
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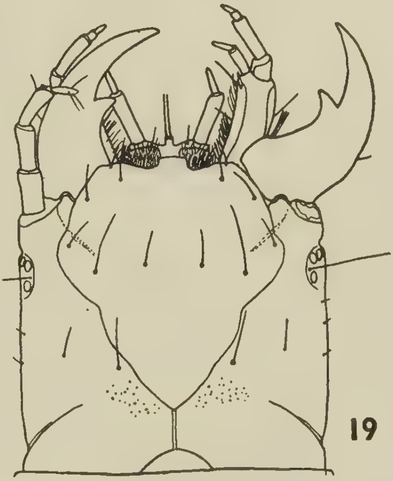

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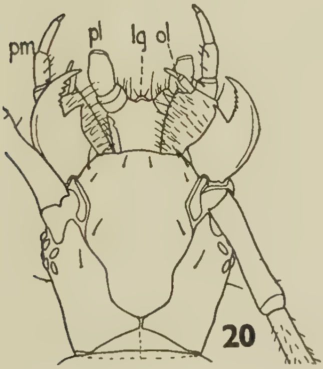

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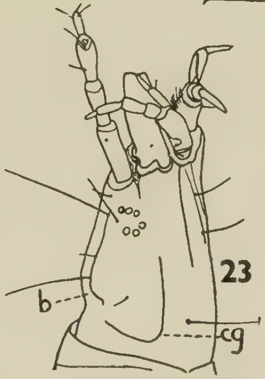

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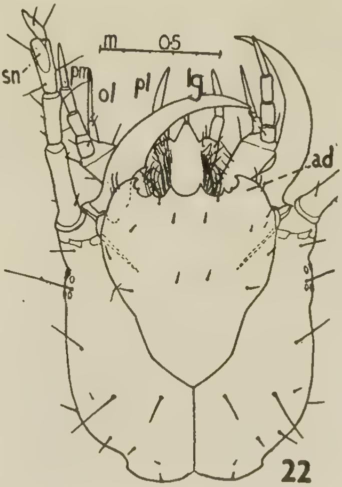
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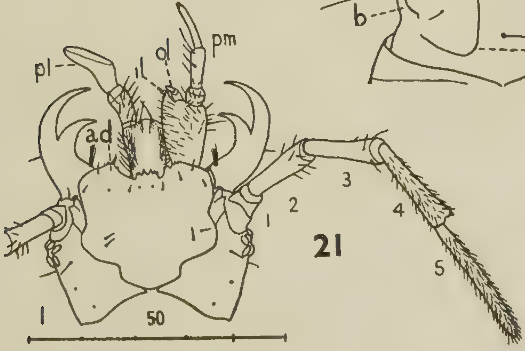
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Fig. 24.—*Bembidion testaceum* Duftschmid. Nasale. L 3, 6, n.

Fig. 25.—*Asaphidion flavipes* L. L I. Nasale. L 2, 6, o.

Fig. 26.—*Tachys* (*Tachyta*) *nanus* Gyllenhal. Nasale. L 1, 6, p.

Fig. 27.—*Pogonus luridipennis* Germar ? L III, Sülldorf. Nasale. L 2, 3, d.

Fig. 28.—*Diachromus germanus* L. ? L I. Nasale. L 4, 3, g.

Fig. 29.—*Calosoma inquisitor* L. Nasale. L 0, 2, c.

Fig. 30.—*Molops piceus* Panzer. Nasale. L 1, 3, k.

Fig. 31.—*Zabrus tenebrioides* Goeze. L I, C. Europe. Nasale. L 2, 3, d.

Fig. 32.—*Harpalus* (*Ophonus*) *stictus* Stephens. L III. Nasale.

Fig. 33.—*Dromius* sp. ? Hamburg. Nasale. L 0, 6, q.

Fig. 34.—*Oecornis nidicola* Britton. *a*. L III. Nasale and mandible. L 4, 3, r. *b*. L I. Nasale. L 0, 6, s.

Fig. 35.—*Anaulacus fasciatus* Schmidt-Goebel. L III, left hind tarsus. L 3, 3, t.

Fig. 36.—*Perileptus areolatus* Creutzer. *a*. L I, left fore tarsus. L 2, 6, o. *b*. L III, left hind tarsus. L 2, 6, o.

Fig. 37.—*Galerita* sp. Costa Rica. Apical part of right mid tarsus, ventral view. L 0, 6, u.

Fig. 38.—*Tachys* (*Tachyta*) *nanus* Gyllenhal. Left fore tarsus. L 0, 6, u.

Fig. 39.—*Broscus cephalotes* L. L III Zibelle. Tibia and tarsus. L 1, 2, i.

Fig. 40.—*Dromius* sp. ? Hamburg. Right mid leg. L 4, 3, j.

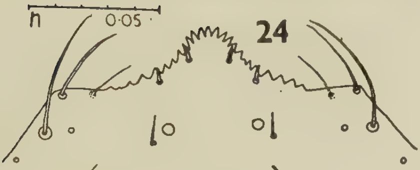
Fig. 41.—*Physea setosa* Chaudoir. Right fore leg. L 1, 2, e.

Fig. 42.—*Desera* sp. ? *a*. Apical part of leg. L 0, 2, c. *b*. Apical part of tarsus. L 0, 6, u.

Fig. 43.—*Drypta* sp. Apical part of tarsus. L 0, 6, u.

Fig. 44.—*Asaphidion flavipes* L. L I, left fore tarsus. L 2, 6, o.

Fig. 45.—*Onota angulicollis* Reiche ? Apical part of right fore tarsus. L 2, 6, 0.



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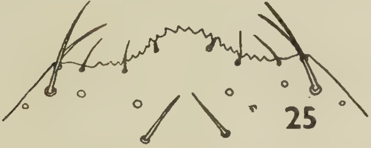

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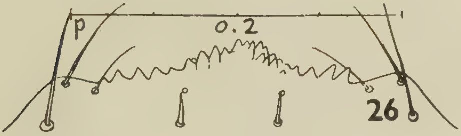

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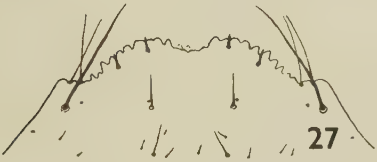

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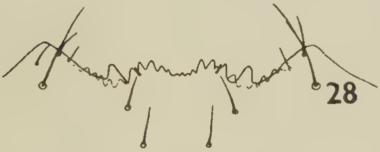

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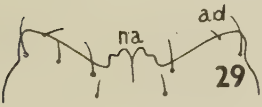

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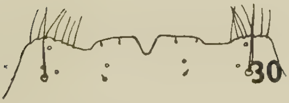

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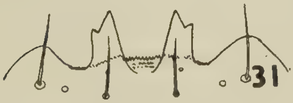

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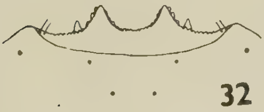

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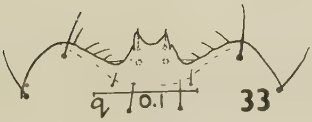

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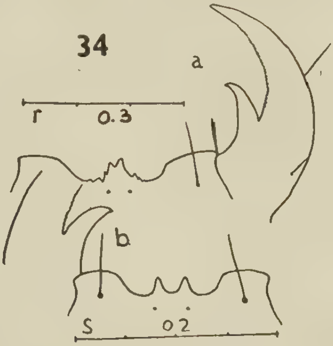

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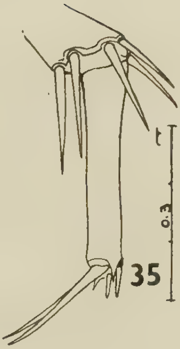

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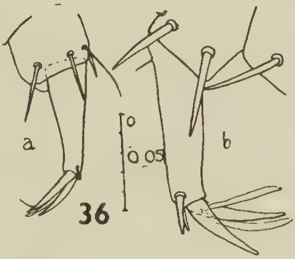

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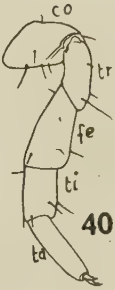
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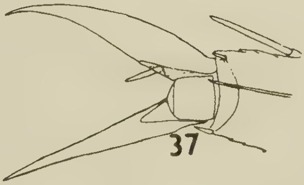

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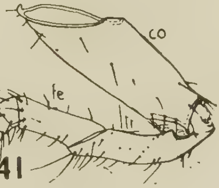

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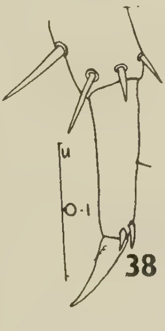

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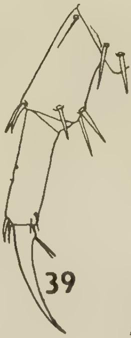

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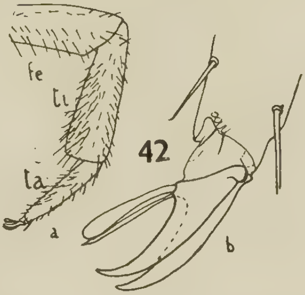

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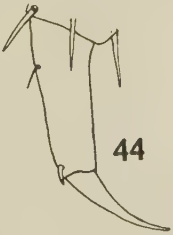

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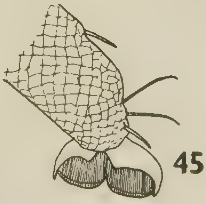

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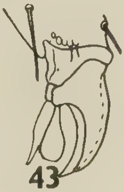

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Fig. 46.—*Tachys* (*Tachyta*) *nanus* Gyllenhal. Apex of left maxilla, dorsal view. L 0, 6, u.

Fig. 47.—*Calathus fuscipes* Goeze. L III, Riesa. Inner lobe and surrounding parts of left maxilla, dorsal view. L 0, 6, u.

Fig. 48.—*Loricera pilicornis* Fabricius. Schkeuditz. Apex of right maxilla, dorsal view. L 2, 3, d.

Fig. 49.—*Speotrechus humeralis* Dodero. Right maxilla and labial palp, dorsal view. L 4, 3, g.

Fig. 50.—*Harpalus* (*Ophonus*) *stictus* Stephens. L III. Left maxilla, dorsal view.

Fig. 51.—*Scarites subterraneus quadriceps* Chaudoir. Right antenna, dorso-exterior view. Z 2, a_2, f.

Fig. 52.—*Agonum mülleri* Herbst. *a.* Left maxilla, dorsal view. L 3, 3, t. *b.* Inner lobe, more strongly enlarged. L 0, 6, u.

Fig. 53.—*Tetragonoderus elegans* Andrewes. Apex of left maxilla, dorsal view, after Gardner.

Fig. 54.—*Diceromerus orientalis* Hope. Inner lobe and surrounding part of maxilla, ventral view, inner lobe seen by transparence. L 2, 6, v.

Fig. 55.—*Molops piceus* Panzer. *a.* Right maxilla, dorsal view. L 1, 3, k. *b.* Inner lobe, strongly enlarged. L 0, 6, u.

Fig. 56.—*Molops piceus* Panzer. Right antenna, dorsal view. L 1, 3, k.

Fig. 57.—*Onota angulicollis* Reiche ? Left mandible, dorsal view. L 0, 6, u.

Fig. 58.—*Barysomus* sp. ? Right mandible, dorsal view. L 0, 3, w.

Fig. 59.—*Harpalus* (*Ophonus*) *stictus* Stephens. L III, left mandible, dorsal view.

Fig. 60.—*Harpalus* (*Ophonus*) *stictus* Stephens. L III, labium, ventral view.

Fig. 61.—*Agonoderus lineola* Fabricius. Labium, ventral view. L 2, 3, d.

Fig. 62.—*Chlaenius sericeus* Forster ? Part of labium, ventral view. L 0, 3, w.

Fig. 63.—*Bembidion dalmatinum* Dejean. L I, right hind part of frontal piece and inner part of right parietale. L 0, 6, u.

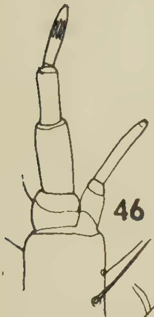
Fig. 64.—*Asaphidion flavipes* L. L I, right hind part of frontal piece and inner part of right parietale. L 2, 6, o.

Fig. 65.—*Zabrus tenebrioides* Goeze. L I, left egg-burster. L 0, 6, u.

Fig. 66.—*Diachromus germanus* L. ? L I, left egg-burster. L 4, 3, g.

Fig. 67.—*Amara* (*Bradytus*) *consularis* Duftschmid. L I, left egg-burster. L 0, 6, u.

Fig. 68.—*Pheropsophus hispanicus* Dejean. L I, egg-burster. L 0, 6, u.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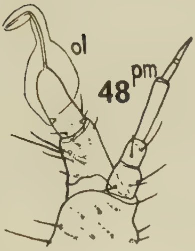
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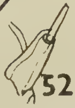
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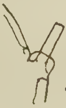
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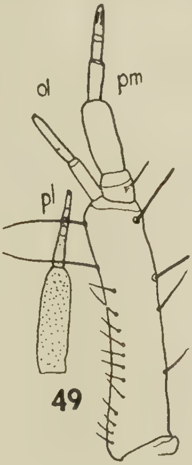
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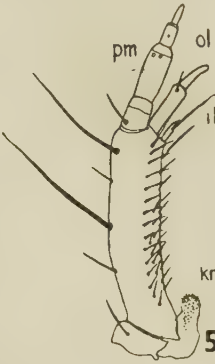
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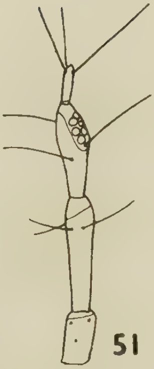
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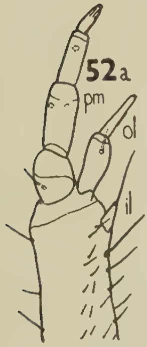
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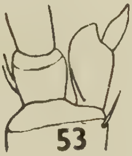
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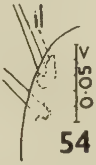
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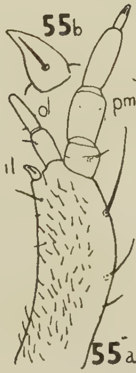
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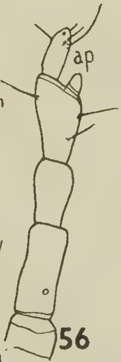
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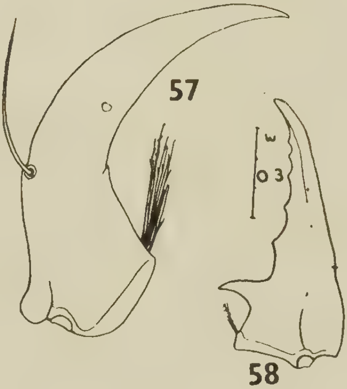
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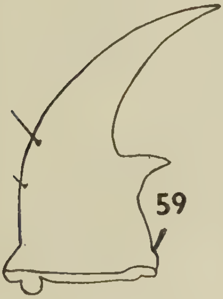
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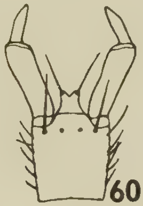
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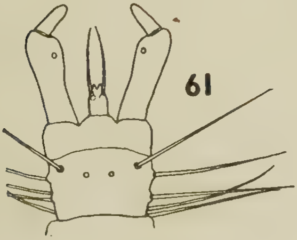
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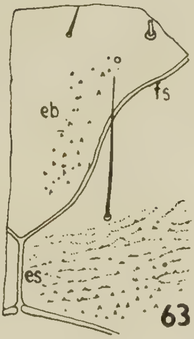
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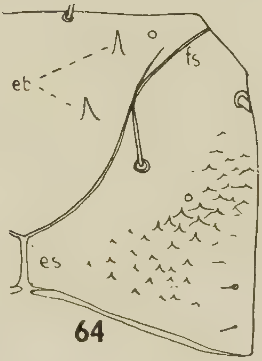
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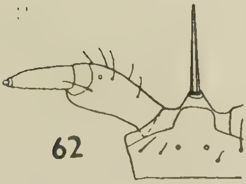
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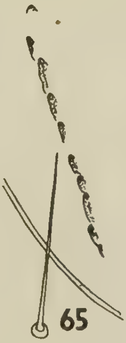
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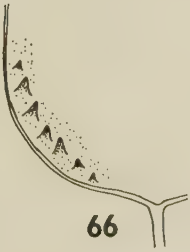
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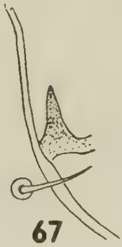
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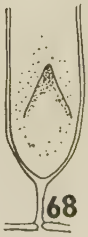
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Fig. 69.—*Leistus spinibarbis* Fabricius. Eighth to tenth abdominal segments with cerci. L 0, 2, c.

Fig. 70.—*Feronia madida* Fabricius. L III. Seventh to tenth abdominal segments with cerci. Z 2, a_0, h.

Fig. 71.—*Trichosternus vigil* White. Seventh to tenth abdominal segments with cerci. Z 2, f55, l.

Fig. 72.—*Ceroglossus suturalis* Fabricius. Est. Viamonde. Sixth to tenth abdominal segments, with basal part of cerci, rest broken. Z 2, a_0, h.

Fig. 73.—*Elaphrus cupreus* Duftschmid. Stotternheim. Eighth to tenth abdominal segments with cerci. L 0, 2, c.

Fig. 74.—*Blethisa multipunctata* L. Cerci. L 0, 2, c.

Fig. 75.—*Calosoma inquisitor* L. Sixth to tenth abdominal segments with cerci. Z 2, a_0, h.

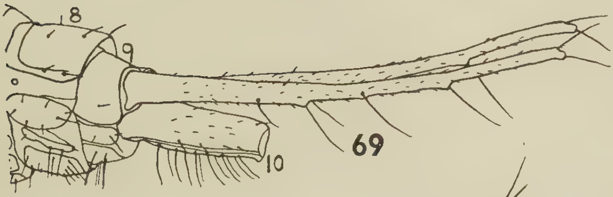
Fig. 76.—*Clivina fossor* L. Sixth to tenth abdominal segments with cerci, dorso-lateral view. The dotted line on the right cercus indicates the ventral excavation. Z 2, a_2, f.

Fig. 77.—*Cratacanthus dubius* Beauvois. Seventh to tenth abdominal segments with cerci. (Poor specimen, most setae lost, but drawn.) Z 2, a_2, f.

Fig. 78.—*Harpalus* (*Pseudophonus*) *rufipes* Degeer. L III, Riesa. Seventh to tenth abdominal segments with cerci. Z 2, a_0, h.

Fig. 79.—*Chlaenius sericeus* Forster ? *a.* Seventh to tenth abdominal segments with cerci. L 2, a_0, h. *b.* Part of right cercus, more strongly enlarged. Z 2, a_2, f.

Fig. 80.—*Craspedophorus* sp. Ukerewe. Seventh to tenth abdominal segments with cerci. Z 2, f55, l.



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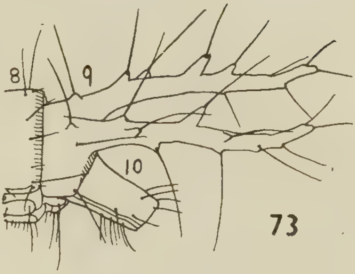

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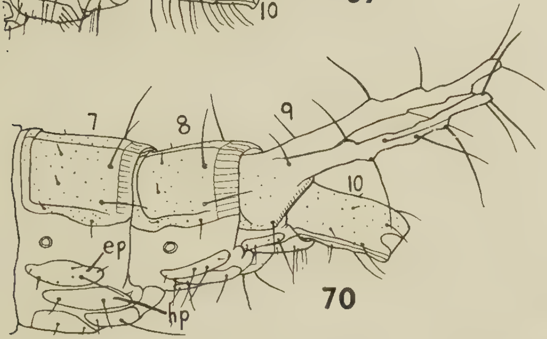

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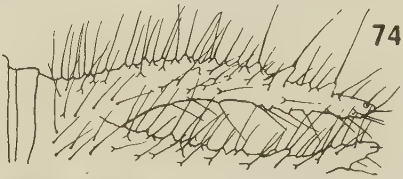

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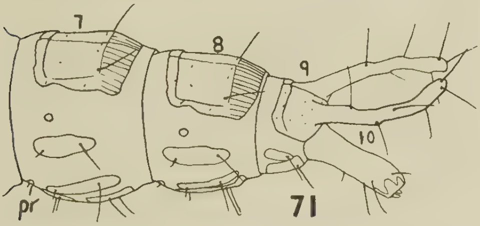

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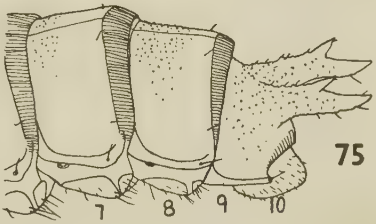

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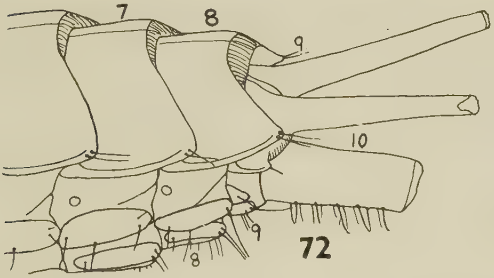

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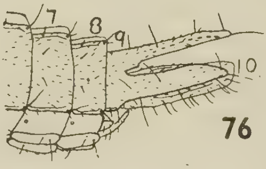

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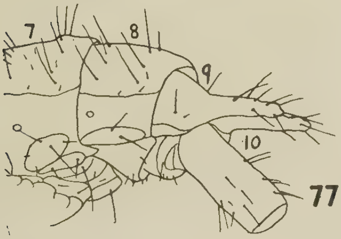

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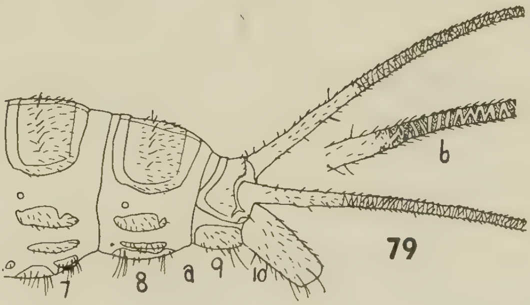

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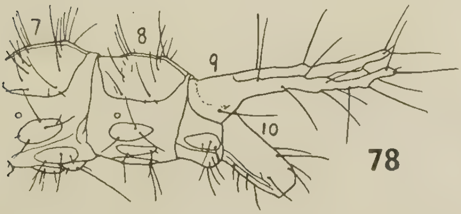

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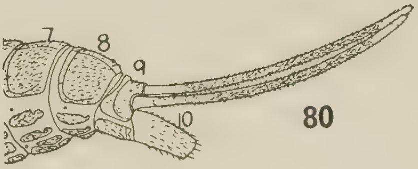

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FIG. 81.—*Onota angulicollis* Reiche ? Eighth to tenth abdominal segments with cerci, the latter whitish from ↑ to apex. L 3, 2, x.

FIG. 82.—*Tefflus juvenilis muansanus* Kolbe ? Seventh to eighth abdominal segments with cerci. Stippled parts yellowish orange. Z 2, f55, l.

FIG. 83.—Zuphiini gen. sp. ? Seventh to tenth abdominal segments with left cercus. Z 2, a_2, f.

FIG. 84.—*Eccoptoptera mutilloides mela* Strohmeyer ? Eighth to tenth abdominal segments with cerci. Z 2, a_2, f.

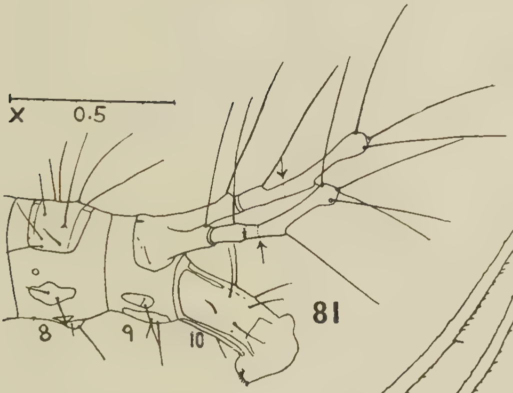
FIG. 85.—*Triaenogenius sculpturatus* Gerstäcker ? Seventh to tenth abdominal segments with cerci. Z 2, a_0, h.

FIG. 86.—*Catascopus* sp. ? Poor specimen. Eighth to tenth abdominal segments with left cercus (apex broken). 7–8 metallic green, 9–10 and cerci to A yellowish orange, A to B dark with metallic blue reflections and pale membranes, B to apex whitish. Crotchets (*cr*) seen by transparence. Z 2, f55, l.

FIG. 87.—*Desera* sp. ? Fourth to tenth abdominal segments, ventral view. Z 2, a_2, f.

FIG. 88.—*Arsinoe grandis* Péringuey. Seventh to tenth abdominal segments, with cerci, ventral view. L 0, 2, c.

FIG. 89.—*Storthodontus coquereli amplipennis* Bänninger. Fourth abdominal segment, ventral view. t. overlapping part of tergite. Z 2, a_0, h.



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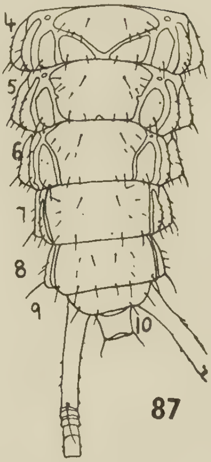

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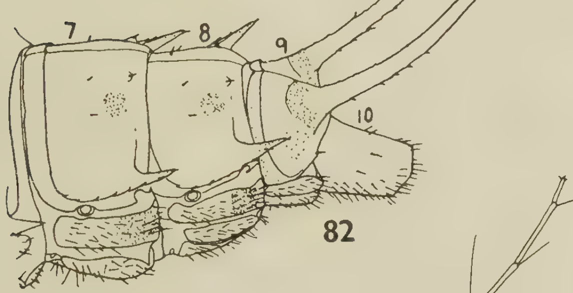

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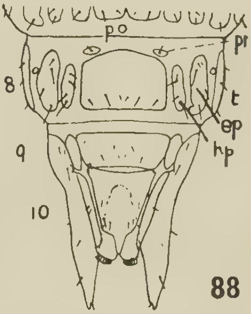
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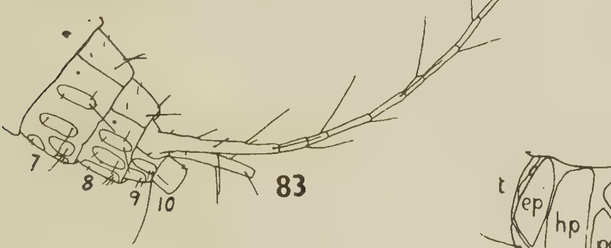

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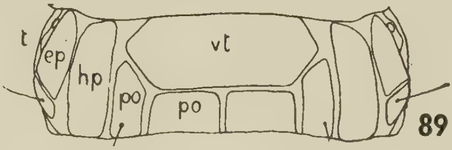
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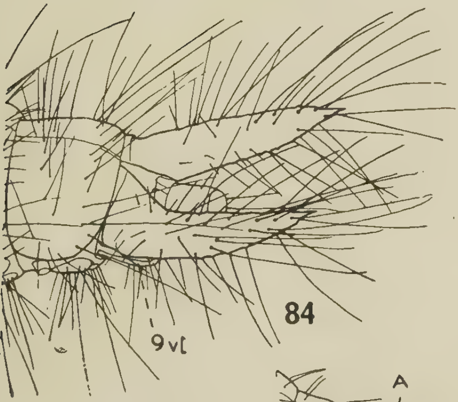

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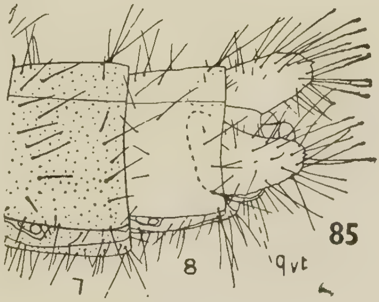

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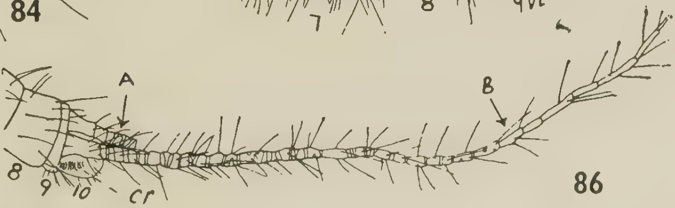

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Fig. 90.—*Cnemacanthus desmaresti darwini* Waterhouse ? Head and prothorax, dorsal view. Figs. 90–97 C. Bruch delin.

Fig. 91.—The same. Head, dorsal view.

Fig. 92.—The same. Head, ventral view.

Fig. 93.—The same, first and second abdominal segments, dorsal view.

Fig. 94.—The same, eighth to tenth abdominal segments, dorsal view.

Fig. 95.—The same, last three segments of right antenna, dorsal view.

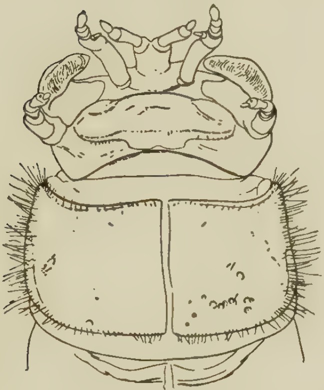
Fig. 96.—The same, leg, side view.

Fig. 97.—The same, leg, ventral view.

Fig. 98.—*Galerita* sp. Head, dorsal view.

Fig. 99.—*Abax ater* Villers. Cerci and tenth abdominal segment, dorsal view.

Fig. 100.—*Diceromerus orientalis* Hope. Left fore leg. L 2, 2, y.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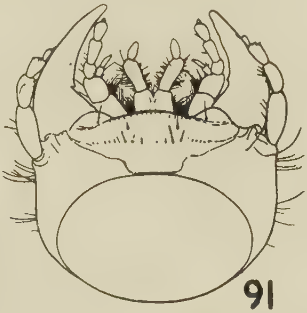
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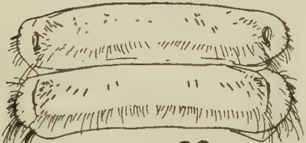
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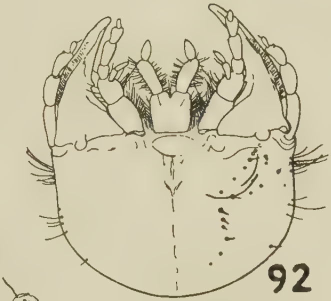
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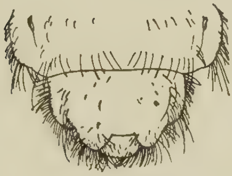
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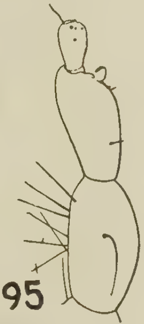
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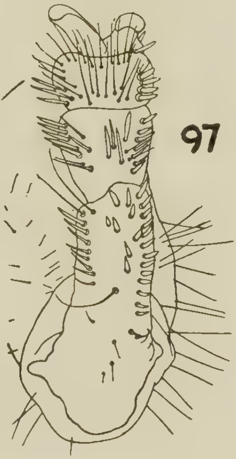
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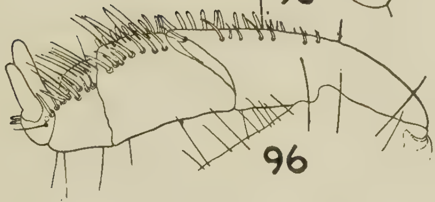
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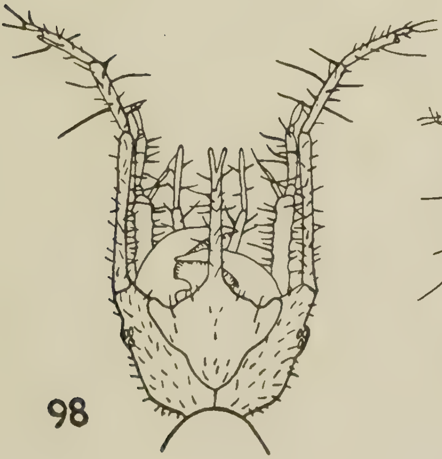
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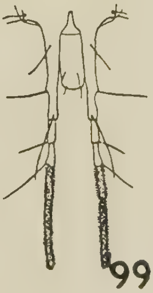
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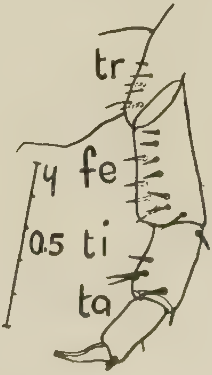
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STUDIES IN THE MIGRATION OF LEPIDOPTERA

By C. B. Williams, Sc.D., G. F. Cockbill, Ph.D., M. E. Gibbs, M.A.,
(*Rothamsted Experimental Station.*)
and
J. A. Downes, B.Sc., A.R.C.S.
(*Department of Zoology, University of Glasgow.*)

Read 5th November, 1941.

With Two Plates and Sixty Diagrams and Maps.

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TRANS. R. ENT. SOC. LOND. 92. PART 1. (JULY 1942.)

I. Introduction.

In 1930 the senior author published (Williams 1930b) a survey of the evidence available on the subject of the migration of butterflies, and discussed many of the problems arising out of an analysis of this evidence.

In the intervening ten years considerable progress has been made and in particular the collection and study of records have been greatly facilitated by three events.

Firstly, in 1931 a group of amateurs was organised by Captain T. Dannreuther to observe the immigration of insects on the south coast of Britain. Under his enthusiastic leadership the organisation has spread to cover the greater part of the British Isles, with its nucleus in the " Insect Immigration Committee " of the South-Eastern Union of Scientific Societies. Through its action numerous records have been sent in not only from the land but also, with the co-operation of Trinity House, from the lightships and lighthouses off our coast.

Secondly, in 1937 the National Geographic Society of America published in their magazine a semi-popular article on Butterfly Migration (Williams 1937a). This magazine has a monthly circulation of over a million copies and, as a result of the publicity obtained, between two and three hundred correspondents sent in their observations. Some of these have continued to co-operate and have produced information of first-class importance.

Finally, in 1938 the Leverhulme Research Fellowship Trust made a grant for two years which enabled a full-time research entomologist and a clerk to be employed at Rothamsted.

On two occasions also the British Association for the Advancement of Science made small grants from which it was possible to purchase necessary filing material and other equipment; and the Royal Society has contributed £100 towards the cost of publication of this report.

The results presented are largely dependent on the help received from these organisations, and this opportunity is taken to thank them, and also Sir John Russell, Director of Rothamsted Experimental Station, for his encouragement of the work carried out there.

Mr. J. A. Downes wishes to express his thanks to Professors W. B. Herms and E. C. Van Dyke of the University of California for help during his investigations in that State.

G. F. Cockbill is author of the sections on the history of British migrants; the influence of the magnetic field; the results of marking insects, and the inter-correlations between the British migrants. These are part of a thesis accepted by the University of London for the Degree of Ph.D.

Miss M. E. Gibbs is author of the section on the records at the British light vessels.

J. A. Downes is author of the section on the migrations and reproductive cycle of *D. plexippus* in California, this being based on observations made during the tenure of a Commonwealth Fund Fellowship.

The rest of the report is by C. B. Williams.

The Bibliography (p. 264) contains all the references to the migration of Butterflies that we have been able to trace, and which are not in the Bibliography in Williams' book, including both older ones accidentally omitted from this and those published subsequently. Thus the bibliography in Williams' " Migration of Butterflies " (1930b) plus the Bibliography here is as complete a list as possible of the literature on the subject.

II. SOME EARLY REFERENCES TO MIGRATION.

By C. B. WILLIAMS.

Some early references to the migration of butterflies have already been given (Williams 1930b, p. 12). Since then others have been traced which appear to be worth putting on record for their historical interest.

1100.

In F. Schnürrer's *Chronik der Seuchen* (*History of Calamities*) **1** : 229 (published in 1825) under the year 1100 A.D. there is the passage : " In Germany there were seen passing from the direction of Saxony to Bavaria swarms of insects, which from the resemblance of their outspread wings to tents, were called ' Papilloren '." Schnürrer does not give the source of his information.

The word " Papilio " was used in Latin both for " tents " and for " butterflies." It seems possible that the insects were Cabbage White butterflies.

1508.

One of the most remarkable early records of a flight of butterflies that has so far been traced is that in Richard Turpyn's " The Chronicles of Calais in the Reigns of Henry VII and Henry VIII to the Year Fifteen Forty." The manuscript is in the British Museum and extracts from it were printed by the Camden Society, Vol. 35 (1846). On p. 7 of this volume appears " [1508] the twenty third of Henry the Seventh the ninth of July, beinge relyke Sonday, there was sene at Calleys [Calais] an innumerable swarme of whit buttarflyes cominge so thicke as flakes of snowe, that men being a shutynge in Saint Petar's felde without the towne of Calleys cowld not se the towne at fowre of the cloke in the aftarnone, they flewe so highe and so thicke."

I am indebted to Mrs. C. Lenanton for this interesting reference, which undoubtedly refers to a migration of *Pieris brassicae* or *P. rapae.*

In view of the fact that the correction of the calendar had not then been made the date would really be equivalent to about the 19th July in our present reckoning, which fits in well with the migrations that occur today (see p. 189).

1553.

John Sleidan (Sleidanius) in his " General History of the Reformation of the Church " (first published 1555), English edition 1689, book **25**, p. 586, writes as follows about the funeral of Maurice, Duke of Saxony, who died on 11th July, 1553, " When the body of Maurice was carried through Leypsick to be buried, Joaachimus Carerarius made a funeral oration in commendation of him, enumerating also the prodigies which preceded his death, observing that drops of blood were found upon the leaves of some trees . . . and in truth as to what concerns the drops of blood, they were observed in many places (and amongst the rest at Strasburg) to be found frequently in the beginning of July fallen upon herbs, the leaves of trees, stones and tiles of houses. Then there was a vast flight of butterflies, and there were some that were of opinion that these drops of blood proceeded from them; but the others thought they were presages of something that was to happen." The drops of blood appear to indicate a local emergence of large numbers of insects from the chrysalis. The " large flights " might possibly have been migrations, and again the date corresponds with the time of migration of the Cabbage Whites in Germany (see p. 189).

1752.

According to Esper (1777, p. 136) Linnaeus is said to have recorded that *Vanessa cardui* was very abundant at Upsala in Sweden in 1752. No reference is given and I have not been able to trace the original. Linnaeus refers briefly to the abundance in *Fauna Suecica* (2) : 33, but this is later than Esper's reference.

1803.

Haworth in his *Lepidoptera Britannica* (1803) p. 28, commenting on the appearance in England of *Vanessa antiopa*, writes : " There is something very extraordinary in the periodical but irregular appearance of this species, *Papilio edusa* (*Colias hyale* of this work) and *Pap. cardui*. They are plentiful all over the kingdom in some years, after which *antiopa* in particular will not be seen by anyone for eight, ten or more years, and then appears as plentifully as before. To suppose they come from the Continent is an idle conjecture, because the English specimens [of *antiopa*] are easily distinguished from all others by the superior whiteness of their borders. Perhaps the eggs in this climate, like the seeds of some vegetable, may occasionally lie dormant for several years and not hatch until some extraordinary but undiscovered coincidence awakes them into active life."

1827.

One of the earliest of records of butterfly migration in the tropics is by L. Guilding (1827), who writes : " A species of *Colias* was lately sent to me from Trinidad, which was observed in a continued flight of thousands traversing that island from west to east. They were also observed at sea in the neighbouring Gulf."

The species was undoubtedly a *Catopsilia* (*Phoebis*) and probably *P. statira*, which I observed myself in large numbers migrating across Trinidad from east to west ninety years later, in September and October 1918 (1919, Williams, *Trans. ent. Soc. Lond.* **1919** : 76).

It may be interesting to add to these records the following extract from a Creole song from the West Indies, sent to me by Mrs. B. C. Scott. It was told to her in the island of Haiti by a Jamaican negro cook and relates to migrating yellow butterflies known as " Papillon St. Jean."

" A la femme marcher
A la femme marcher
  Femme n'en marcher
Comme yo dit papillons
  La St. Jean
Vinir pran paquet
  Et t'ou allez."

Mrs. Scott sends as a rough translation :—

" Like the marching peasant women,
Yes, the lines of walking women,
  The women who keep on walking,
Like the Butterflies called
  St. John;
Come, take up your bundles,
  [and keep moving]
to wherever you are going."

III. HISTORY OF BRITISH IMMIGRANTS.

By G. F. COCKBILL.

In his monograph on *The Migration of Butterflies*, Williams (1930b) pointed out the value of a historical survey of the British migrant Lepidoptera, and also emphasised that in Britain there was a unique opportunity for such a study because of the wealth of entomological and natural history journals in which were recorded the observations of collectors dating back a hundred years or more.

In 1937, Grant made a historical study of the Hawk moth *C. lineata* Fab. This work showed such possibilities that it was decided to extend the survey to include all the major British immigrants.

Sources of information.

The information was collected from entomological periodicals, general periodicals and Proceedings and Transactions of Natural History Societies. About eight hundred volumes were consulted and about fifty thousand records have been extracted, relating to forty species considered to be regular immigrants to Britain.

It is not practical to include in this paper all the references to the data because of their bulk, but they are available for consultation at the Entomological Department at Rothamsted Experimental Station.

Sources of error.

1. In collecting information from old journals there is always the possibility that some evidence has been overlooked, but the survey has included all the major British entomological periodicals since 1824, so that this error is believed to be at a minimum.

2. There is not much likelihood of errors in the data due to misidentification of species, since, apart from the fact that the British migrant Lepidoptera are fairly distinctive species, the field Lepidopterists, who are mainly responsible for the data, have always taken a pride in their ability to identify species correctly, and the rivalry that arose maintained a high standard of efficiency. Furthermore some magazines demanded inspection of a rare capture for verification.

3. There is a source of error arising from the fact that certain insects have at times enjoyed almost a fashionable interest among Lepidopterists during the past century, and consequently received increased attention in the literature until the interest waned. However, the rare migrant species have always been of sufficient interest to have been fully recorded whenever they occurred.

4. It is to be expected that rare occurrences tend to be recorded more fully than commonplace events. Thus rare insects, and conspicuous abundances or absences of common species, will be recorded; while normal abundances of the commoner species may receive less attention in the literature. To take an extreme case, it is likely that almost every capture or observation of *D. plexippus* in Britain has been recorded. On the other hand, *P. brassicae* is mentioned only when it becomes a particular pest, or when crops are singularly free from it; when there is no mention of *P. brassicae* in the literature it means that there is a normal abundance of the insect, and not that it is absent.

5. The number of entomologists has increased as time has passed, and a corresponding increase in the number of observations might be expected. It must be borne in mind, however, that while the number of entomologists has

increased, their interests have become more diverse, and that whereas formerly Entomology was almost synonymous with the collection of Lepidoptera, it has now a far wider significance. The result is that the number of Lepidopterists contributing records to the literature of migrant insects does not appear to have been greatly affected until quite recently.

A special instance of this type of error is shown in the increased interest in migration of Lepidoptera since 1931, due to the activities of the Insect Immigration Committee of the South-Eastern Union of Scientific Societies. In this case, so numerous have the records of migrant Lepidoptera become that they must be considered separately from the previous records, so as not to throw the survey out of balance.

In spite of these apparently formidable errors, it is considered that there is still left a basis for a comparative analysis of species' abundances, and that the large bulk of data available in the past literature, if used discriminately, will yield valuable information. It must be emphasised that the numbers of insects obtained by this method are samples of the population, and give little, if any information of the absolute numbers of immigrants.

Method of grading abundances.

The recorded numbers of each species have been summed up as monthly and yearly totals. In order to compare the abundances of species readily, the annual totals for each species have been divided into six geometrically related grades. The grade of least abundance being Grade 1, and that of greatest abundance being Grade 6. In this way, abundances of rare and of regular migrants can be compared with due consideration for their particular degree of commonness.

Roughly speaking, the grades correspond to the following common verbal descriptions.

Grade.		Grade.	
1.	Very rare or absent.	4.	Common.
2.	Rare.	5.	Very common.
3.	Not rare.	6.	Quite unusually abundant.

Each description is of course taken as applying to the particular insect concerned. Thus only 25 *V. cardui* recorded in a year would be "rare" but the same number of *D. plexippus* would be "quite unusually abundant."

The highest annual total recorded for each species has been amplified by fitting a sliding scale, which gives a 10% amplification at a maximum of 10 insects and a 50% increase at a maximum of 10,000 insects in one year. This device allows the highest recorded annual total to fall near the mean of Grade 6. Without amplification this would represent the extreme limit of the grade. The system also provides for the inclusion of higher totals than have yet been recorded, without upsetting the grading.

In addition, the amplification at higher levels tends to counteract the error of under-estimation of observers when large numbers of insects are seen; and at lower levels to compensate for the fact that when there is only a small immigration, the records tend to be limited by the numbers of insects, but when large immigrations occur, they tend to be limited by the number of observers.

In the first instance, when there is a very small immigration an increase in observers would probably have little effect on the number of insects recorded, but in the second case, when great numbers of insects are about, an increase in the numbers of observers would greatly affect the numbers of insects recorded.

In the case of the regular immigrants, the grades are arrived at by dividing the logarithm of the amplified total of the year of greatest abundance into six equal divisions. The corresponding antilogs. are obtained, and the yearly totals are provided with an index number, according to the grade in which each falls.

In the case of the rare migrants, Grade 1 is taken to be an absence of insects, and the range from 1 insect to the amplified maximum total is divided into five geometrically related grades. In taking Grade 1 as 0 insects, the assumption is made that an absence of records meant an absence of insects, and is to be regarded as being of the same category as an extreme rarity of the regular migrants, among which Grade 1 may include a very small number of insects, never more than 4, however, even in the most abundant species.

This method of arranging the annual totals into grades in geometrical proportion also makes it necessary that errors accompanying any year's total would have to be large to cause it to be placed in the wrong grade.

To take two examples (Table 1), *C. croceus* is representative of a common migrant and *A. lathonia* of a rare migrant.

The maximum annual total of records of *C. croceus* was 8778 in 1892. This figure, when amplified, became 13,180, which gave six logarithmic grades as shown. Grade 1 included 0–4 insects. The highest annual total of *A. lathonia* was 50 in 1872; when amplified this total became 67. The grades are shown in Table 1 with Grade 1 being 0 insects.

Table 1.

Method of grading a common and a rare immigrant for annual abundance.

Species	Maximum Annual Total	Amplified Total	Grades					
			1	2	3	4	5	6
C. croceus .	8,778	13,180	0–4	5–23	24–114	115–558	559–2,710	2,711–13,180
A. lathonia .	50	67	0	1–2	3–5	6–12	13–29	30–67

The maximum annual totals and grade range of all species are shown in Table 2. The totals are the highest for the period 1824 to 1939 except in the cases of *P. napi*, *V. cardui*, *V. atalanta* and *P. gamma*, where they are the highest for the period 1824 to 1931.

In Table 3 the total monthly records for each species from 1824 to 1939 and the grand totals are shown. The grand totals of *P. rapae* and *P. gamma* are given for the period 1824 to 1931 only. The totals for the months where peaks of abundance occur are shown in heavy type. It will be seen that in some cases there are two peaks, one in spring and the other in late summer.

Table 4 (A–D) shows the annual totals of all species for the period 1824 to 1931. Absences of records are shown by dashes. The species are arranged in families.

Figs. 1, 2, 3 and 4 show the grade indices of the Butterflies, Hawk-moths, Noctuids and miscellaneous species respectively in the form of histograms. A dotted vertical line indicates the year when the records for each species began. The years 1857 and 1931, between which most of the correlations were calculated (see p. 254), are marked by a dotted vertical line passing through all species. In all these figures the base line represents Grade 1.

Constant reference will be made later to the above diagrams and tables.

History of the Species.

Danaus plexippus (fig. 1).

This immigrant from America is fully dealt with on p. 174 and will not be commented upon here.

Nymphalis antiopa (fig. 1).

In 1828, two were taken. It has appeared fairly regularly since then (Table 4) but usually in small numbers as shown by the preponderance of Grades 2 and 3 in fig. 1. It has been unrecorded in 18 years. An exceptional

Table 2.

Maximum annual records and range of grades for British Immigrants, 1824–1939.

	Max. annual total	Grade					
		1	2	3	4	5	6
P. rapae	3,051	0–4	5–13	14–66	67–270	271–1,096	1,097–4,467
P. napi (to 1931)	600	0–3	4–9	10–29	30–87	88–275	276–851
P. daplidice	35	0	1–2	3–4	5–9	10–20	21–44
C. croceus	8,778	0–4	5–23	24–114	115–558	559–2,710	2,711–13,180
C. hyale	2,203	0–3	4–14	15–56	57–218	219–841	842–3,236
V. cardui (to 1931)	3,281	0–4	5–16	17–68	69–279	280–1,143	1,144–4,677
V. atalanta (to 1931)	2,114	0–3	4–14	15–54	55–208	209–794	795–3,020
N. antiopa	436	0	1–3	4–12	13–45	46–161	162–575
A. lathonia	50	0	1–2	3–5	6–12	13–29	30–67
C. semiargus	20	0	1	2–3	4–7	8–13	14–26
D. plexippus	37	0	1–2	3–4	5–10	11–22	23–50
L. exigua	315	0	1–3	4–11	12–38	39–131	132–447
C. ambigua	310	0–2	3–7	8–20	21–58	59–158	159–440
H. armigera	28	0	1–2	3–4	5–8	9–17	18–38
M. peltigera	42	0–1	2–3	4–7	8–14	15–28	29–56
A. ipsilon	2,700	0–3	4–15	16–61	62–245	246–980	981–3,890
P. porphyrea	1,020	0–3	4–11	12–38	39–127	128–429	430–1,445
L. albipuncta	77	0–2	3–5	6–10	11–21	22–46	47–99
L. vitellina	76	0	1–2	3–6	7–15	16–39	40–99
L. unipuncta	146	0	1–2	3–8	9–24	25–71	72–209
C. fraxini	9	0	1	2	3–4	5–7	8–12
P. gamma (to 1931)	3,331	0–4	5–16	17–69	70–288	289–1,189	1,190–4,898
A. atropos	86	0–2	3–4	5–10	11–23	24–51	52–114
H. convolvuli	681	0–3	4–9	10–30	31–96	97–304	305–955
C. galii	71	0	1–2	3–6	7–14	15–36	37–89
C. livornica	142	0	1–2	3–8	9–24	25–70	71–204
H. celerio	41	0	1–2	3–5	6–10	11–24	25–54
M. stellatarum	1,078	0–3	4–11	12–38	39–131	132–446	447–1,514
U. pulchella	49	0	1–2	3–5	6–12	13–28	29–66
L. salicis	500	0–2	3–8	9–26	27–77	78–231	232–690
R. sacraria	33	0	1–2	3–4	5–9	10–20	21–44
N. obstipata	28	0–1	2–3	4–6	7–11	12–20	21–38
N. noctuella	1,570	0–3	4–13	14–47	48–173	174–631	632–2,290
H. ferrugalis	230	0–2	3–6	7–16	17–40	41–103	104–263

TABLE 3.

Monthly total records and grand total of British Immigrants, 1824–1939.
Peak months in **heavy type.**

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	No date	Grand total
P. rapae (to 1931)	8	25	197	366	**1,300**	1,163	2,649	**9,693**	1,069	97	2	4	3,381	19,754
P. napi	1	—	42	230	**1,147**	716	754	**2,066**	177	203	—	—	2,145	7,481
P. daplidice	—	—	—	—	2	3	17	**91**	12	—	—	—	241	366
C. croceus	—	2	2	32	282	**2,835**	1,102	**27,105**	10,031	2,462	234	2	3,012	47,101
C. hyale	—	—	1	1	17	98	66	**4,269**	1,131	76	1	—	865	6,525
V. cardui	4	10	119	98	2,934	**10,757**	3,209	**9,959**	7,329	1,816	38	4	5,258	41,535
N. antiopa	2	4	13	**36**	15	13	17	**370**	272	20	5	2	242	1,011
A. lathonia	—	—	—	—	2	6	17	89	**118**	7	2	—	68	309
C. semiargus	—	—	—	—	2	**41**	15	2	—	—	—	—	40	100
C. boeticus	—	—	—	—	—	—	2	6	**16**	3	—	—	2	29
E. argiades	—	—	—	—	—	—	—	4	1	—	—	—	2	7
D. plexippus	—	—	1	1	1	2	9	23	**72**	23	—	—	14	146
L. exigua	—	—	1	1	12	**41**	14	188	**387**	78	—	—	249	971
C. ambigua	—	—	—	—	1	7	11	**571**	179	15	—	—	114	898
H. armigera	—	—	—	—	—	4	1	24	**44**	33	—	—	30	136
H. peltigera	1	1	2	2	8	**48**	14	30	**55**	2	—	—	33	196
A. ipsilon	—	3	**21**	9	6	22	37	**3,857**	1,404	227	5	—	440	6,031
P. porphyrea	—	—	—	1	10	9	3	188	**1,362**	162	1	—	496	2,232
L. albipuncta	—	—	—	—	—	1	12	**169**	84	5	—	—	113	384
L. l-album	—	—	—	—	—	—	1	—	**256**	3	—	—	4	264
L. vitellina	—	—	—	—	—	—	—	33	**190**	41	2	—	102	368
L. unipuncta	—	—	4	1	—	1	1	7	**55**	9	36	22	59	195
C. fraxini	—	—	—	—	—	—	2	23	**67**	3	—	—	8	103
P. gamma (to 1931)	—	—	2	7	2,557	**3,840**	1,329	**5,221**	2,912	774	27	5	4,573	21,247
C. alchymista	—	—	—	—	—	6	—	—	2	—	—	—	—	8
A. atropos	—	—	1	6	36	**67**	34	85	**224**	161	13	—	250	877
H. convolvuli	—	—	1	2	—	25	30	1,009	**2,670**	312	18	1	1,116	5,184
C. euphorbiae	—	—	—	—	—	2	3	2	1	1	—	—	2	11
C. galii	—	—	—	—	—	8	72	**115**	16	9	—	—	53	276
C. livornica	2	2	2	25	209	**240**	35	50	36	4	2	0	88	695
H. celerio	—	—	1	3	9	3	6	10	**112**	53	15	2	57	271
D. nerii	—	—	—	—	1	3	5	9	**37**	8	—	—	7	70
M. stellatarum	2	7	20	25	137	**815**	**887**	**827**	**790**	228	11	5	1,856	5,610
U. pulchella	—	—	—	—	**35**	**33**	7	13	**64**	43	1	—	35	231
L. salicis	—	—	—	—	—	533	**766**	87	2	1	—	—	208	1,597
R. sacraria	—	—	—	—	2	1	4	**44**	23	14	—	—	13	101
N. obstipata	—	—	—	—	13	13	21	37	42	**57**	7	—	60	250
N. noctuella	—	—	6	—	149	246	190	**1,705**	**1,632**	81	1	—	268	4,278
H. ferrugalis	—	—	—	—	27	**65**	31	**383**	**370**	37	3	—	222	1,138

TABLE 4A.

Number of recorded individuals in each year from 1824 to 1931 for British Immigrant Lepidoptera.

	1824	1825					1830					1835					1840					1845				
D. plexippus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N. antiopa	—	—	—	—	2	1	—	1	1	3	2	1	1	3	—	2	—	2	3	—	2	—	36	7	2	1
V. cardui	—	150	—	123	—	—	2	31	—	62	—	—	1	—	—	—	—	—	—	—	120	—	65	120	—	—
V. atalanta	1	—	—	—	—	—	—	1	—	1	—	—	—	—	1	—	—	—	—	—	120	—	240	—	—	—
A. lathonia	—	—	1	—	—	—	—	2	—	—	3	—	1	—	—	—	1	—	1	—	—	—	8	2	—	—
L. boeticus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N. semiargus	—	20	—	—	—	—	—	—	5	6	—	15	5	6	—	—	—	3	—	—	—	—	—	—	—	2
C. croceus	—	1	50	—	—	—	1	3	—	1	8	37	23	—	1	24	3	5	1	492	187	56	14	145	16	168
C. hyale	—	—	5	—	—	—	—	2	16	20	8	469	4	—	—	—	—	—	581	23	5	—	—	11	1	15
P. daplidice	—	—	1	1	—	—	1	—	—	—	—	3	2	—	—	—	—	1	4	—	—	—	—	—	—	—
P. napi	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P. rapae	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1,300	—	—	—
A. atropos	—	—	—	—	—	—	—	1	1	—	—	—	1	—	—	—	2	—	3	—	—	1	63	1	1	—
H. convolvuli	1	—	1	6	1	7	—	—	1	—	1	2	—	—	—	1	—	5	6	1	—	1	573	2	1	—
C. euphorbiae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
C. galii	—	1	—	—	—	—	1	3	—	—	20	5	1	—	—	—	—	—	1	10	—	—	3	—	—	—
H. celerio	—	—	1	1	—	—	—	—	—	—	1	—	1	—	1	—	—	—	—	1	—	1	14	5	4	—
D. nerii	—	—	—	—	—	—	—	—	2	1	2	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
C. livornica	1	—	—	1	—	2	1	1	1	—	3	—	—	—	—	—	—	—	—	—	4	—	16	1	—	—
M. stellatarum	—	—	2	—	—	—	—	1	—	1	—	10	1	—	—	—	—	—	20	1	3	—	4	—	—	—
A. ipsilon	—	—	—	—	—	—	—	2	20	—	—	—	—	1	—	—	—	32	4	—	11	1	45	1	7	—
P. porphyrea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	3	2	1	—
L. unipuncta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
L. vitellina	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
L. albipuncta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
L. l-album	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C. ambigua	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—
L. exigua	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
H. peltigera	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	1	—	—	—	—	1	—
H. armigera	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
P. gamma	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
C. fraxini	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	1	1	—	—	1	3	—	—	—
N. obstipata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R. sacraria	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U. pulchella	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	5	—	—	—	—	1	—	1	—
L. salicis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
H. ferrugalis	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—
N. noctuella	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—

TABLE 4B.

	1850					1855					1860					1865					1870					1875				
D. plexippus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—
N. antiopa	—	—	3	—	—	4	3	7	44	8	8	1	—	—	1	3	1	6	9	1	7	4	436	30	1	12	8	11	4	2
V. cardui	—	367	—	—	1	1	123	17	724	80	7	5	84	5	—	371	—	121	503	—	1	—	31	—	—	—	—	379	150	2,568
V. atalanta	—	—	—	—	—	—	38	120	150	30	1	—	—	—	—	1	1	2	32	1	—	—	—	—	—	5	60	151	—	1
A. lathonia	1	6	2	—	—	—	—	17	8	8	2	—	—	—	3	13	1	1	46	1	1	3	50	1	15	3	2	—	2	—
L. boeticus	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
N. semiargus	—	—	—	—	1	—	—	1	1	—	1	1	—	—	—	1	—	—	—	—	—	6	—	—	10	1	1	6	—	—
C. croceus	—	3	6	—	—	77	5	396	952	883	—	134	31	1	—	1,046	—	290	35	16	8	10	15	—	—	174	127	7,491	38	368
C. hyale	—	—	—	—	—	13	1	173	49	36	2	—	—	1	—	9	—	10	312	2	6	—	62	—	—	267	14	50	—	1
P. daplidice	—	1	3	—	—	1	1	2	12	17	—	—	—	2	—	1	3	5	—	4	7	35	—	—	—	2	2	—	1	—
P. napi	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P. rapae	—	—	—	—	—	—	—	—	52	—	—	—	—	40	100	—	—	—	154	3,051	—	1	2	6	500	4	1	—	—	100
A. atropos	—	5	—	—	—	—	7	15	16	19	4	2	1	1	3	34	3	7	1	2	1	2	—	—	1	1	2	6	18	5
H. convolvuli	—	1	1	1	1	2	6	28	121	260	7	5	10	19	2	6	1	1	138	8	4	14	2	5	1	325	19	20	2	—
C. euphorbiae	1	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—
C. galii	—	—	—	—	1	—	3	6	6	25	8	—	—	1	1	—	1	—	2	—	71	—	1	—	—	3	1	—	1	—
H. celerio	2	1	4	—	—	—	—	1	1	2	5	—	6	—	3	23	2	6	13	6	3	2	7	3	—	—	2	2	2	2
D. nerii	—	—	1	—	—	—	—	1	1	—	—	—	1	—	—	—	—	1	2	1	—	—	1	1	1	—	1	—	—	—
C. livornica	—	—	—	—	—	—	1	3	3	2	28	2	12	1	2	4	5	14	29	7	50	1	3	—	1	2	2	2	9	4
M. stellatarum	—	1	—	—	—	—	18	9	306	42	3	—	—	—	—	336	11	1	4	28	—	—	1	—	—	—	—	20	—	—
A. ipsilon	—	—	—	—	—	—	1	27	51	10	1	—	3	3	—	—	—	21	8	15	—	—	—	—	—	—	—	2	20	—
P. porphyrea	—	—	—	—	—	—	94	11	102	3	5	—	1	—	1	8	—	44	6	111	15	—	—	—	1	1	12	2	10	—
L. unipuncta	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	3	—
L. vitellina	—	—	—	—	—	—	1	—	2	1	—	—	1	—	—	—	—	—	1	5	1	—	—	—	—	1	—	1	4	—
L. albipuncta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	8	21	60	9	10	3	4	8	15	12	1
L. l-album	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	2	1	—	—	—	—	—	—
C. ambigua	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
L. exigua	—	—	—	—	—	—	4	1	4	1	—	—	2	—	—	—	—	—	1	—	—	—	1	—	—	—	1	3	—	6
H. peltigera	—	—	—	—	—	—	—	—	4	—	—	1	9	—	1	—	—	2	3	2	3	1	—	—	—	—	1	4	3	4
H. armigera	—	—	—	—	—	—	4	1	4	28	2	5	1	3	1	5	1	2	2	4	—	9	1	—	—	—	1	3	1	1
P. gamma	—	—	—	—	—	—	—	121	240	—	120	—	—	—	—	30	—	—	360	—	1	—	—	—	—	—	—	270	—	3,331
C. fraxini	1	—	1	—	1	—	—	—	2	2	—	—	—	—	—	1	1	—	9	1	1	2	5	—	2	1	2	—	—	—
N. obstipata	—	—	—	—	—	—	—	3	15	6	1	—	1	—	—	17	6	28	12	5	—	1	—	—	1	—	—	3	1	—
R. sacraria	—	—	—	—	—	—	—	1	—	5	—	—	—	3	3	11	—	33	1	5	—	1	1	—	1	—	—	2	—	2
U. pulchella	—	—	—	—	—	—	2	—	—	—	1	—	—	—	—	—	—	—	—	4	2	29	1	—	23	24	23	—	4	2
L. salicis	—	—	—	—	—	—	85	1	9	1	—	—	—	—	30	—	—	—	21	—	70	—	—	—	—	—	—	—	500	—
H. ferrugalis	—	—	—	—	—	—	—	220	22	63	—	50	16	—	—	—	—	—	—	—	—	—	20	—	—	—	—	230	—	—
N. noctuella	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1

TABLE 4C.

	1880					1885					1890					1895					1900					1905				
D. plexippus .	—	1	—	—	1	12	9	2	1	—	1	—	—	—	2	1	4	—	—	1	—	—	—	—	—	—	1	—	2	—
N. antiopa .	47	7	2	—	3	2	3	5	8	16	1	—	7	3	1	1	13	1	4	6	37	18	2	2	4	5	3	1	—	4
V. cardui .	31	—	1	682	1,240	211	—	—	691	440	1	2	2,980	56	981	43	3	60	141	377	567	37	547	3,280	293	7	1,130	13	213	3
V. atalanta .	—	36	6	120	704	4	31	127	120	120	—	—	1,244	1,603	154	488	34	338	369	2,114	1,789	37	311	334	135	242	133	12	309	313
A. lathonia .	19	2	25	16	2	2	—	—	—	—	—	—	2	5	—	4	—	—	1	1	—	2	—	—	—	—	—	2	—	—
L. boeticus .	2	—	2	—	—	—	—	—	—	—	1	—	—	3	—	—	—	—	1	3	—	—	—	—	1	—	—	—	1	—
N. semiargus .	1	1	—	2	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
C. croceus .	15	13	10	81	157	175	28	2	63	228	—	4	8,778	787	107	315	8	74	71	405	3,330	87	83	9	198	4	68	18	250	14
C. hyale .	—	1	—	—	—	23	1	—	—	3	1	—	568	37	1	1	4	4	—	58	2,203	409	17	1	32	—	1	—	1	—
P. daplidice .	—	—	2	—	2	2	2	—	—	—	—	—	1	5	5	5	—	—	—	—	1	8	1	1	—	—	206	—	—	—
P. napi .	—	118	55	—	—	120	—	120	—	—	2	121	1	195	—	21	151	205	67	60	202	35	145	6	115	1	50	162	—	100
P. rapae .	1	833	303	—	1	—	1	1,751	5	2	223	803	201	157	51	—	358	326	907	1,111	80	7	13	155	232	2	25	85	4	152
A. atropos .	2	7	28	8	8	14	11	5	7	4	3	8	8	14	3	20	28	7	7	39	36	28	6	10	4	9	4	1	14	11
H. convolvuli .	—	25	1	7	1	225	34	316	11	61	1	61	50	7	4	235	11	57	272	53	21	681	8	19	179	2	20	3	7	2
C. euphorbiae .	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—
C. galii .	—	—	—	—	—	—	—	—	64	7	1	—	2	—	—	—	—	1	—	1	1	—	—	—	—	—	1	—	—	—
H. celerio .	9	2	1	1	3	41	4	—	4	1	1	1	9	—	4	7	1	2	7	2	1	1	4	4	—	1	3	1	1	—
D. nerii .	—	—	—	—	3	1	2	—	3	—	1	—	1	—	—	—	2	—	—	—	5	—	1	1	1	—	3	1	—	1
C. livornica .	3	—	—	8	4	5	—	1	8	—	2	1	7	2	9	3	6	—	4	4	6	2	1	1	39	10	99	—	—	3
M. stellatarum	—	1	1	106	20	21	—	12	1	1	26	—	203	503	45	10	2	7	48	1,078	201	85	10	1	36	—	32	—	3	2
A. ipsilon .	30	1	—	—	1	—	—	—	—	31	6	14	196	23	13	9	3	12	6	39	91	34	35	38	2	1	30	3	1	1
P. porphyrea .	2	2	—	—	—	—	—	—	—	2	1	5	263	24	6	24	3	—	30	42	68	19	2	6	—	2	4	18	15	2
L. unipuncta .	—	—	—	—	—	—	—	—	—	—	—	2	—	1	—	—	3	4	—	—	1	1	—	1	—	—	3	2	—	—
L. vitellina .	—	—	—	—	—	—	1	—	—	4	3	2	—	9	1	2	1	—	2	8	58	23	2	2	—	—	2	15	30	2
L. albipuncta .	—	—	—	—	—	—	—	—	—	—	—	4	—	4	18	3	4	5	1	6	32	7	14	—	1	1	—	—	3	—
L. l-album .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	1
C. ambigua .	—	—	—	—	—	1	—	1	3	5	—	—	—	1	25	—	8	310	62	82	216	71	51	—	5	—	1	14	10	—
L. exigua .	1	—	—	2	12	—	1	—	6	—	—	1	1	—	2	—	1	48	3	94	20	13	2	29	1	—	235	—	1	1
H. peltigera .	3	—	—	2	2	3	—	1	5	—	—	—	—	—	2	—	—	9	3	1	—	1	—	1	2	—	42	1	—	—
H. armigera .	—	2	1	—	—	—	1	—	—	—	1	—	1	—	5	1	1	2	6	6	10	7	1	2	—	—	4	—	—	—
P. gamma .	—	156	137	1,440	120	—	240	—	1,020	241	20	230	2,497	20	677	322	11	331	340	3	2,478	35	764	952	518	—	762	2	70	1
C. fraxini .	7	—	—	1	—	1	—	2	2	3	2	—	—	1	1	5	5	—	—	—	3	3	—	—	—	2	—	—	1	1
N. obstipata .	5	—	—	1	—	—	—	—	1	—	—	—	6	3	—	—	—	2	4	23	1	1	1	3	3	—	—	2	11	1
R. sacraria .	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	1	—	—	1	—	1	—	—	—	—	1	2	—	1	—
U. pulchella .	7	1	—	1	1	4	5	—	—	—	—	1	49	—	2	1	2	—	—	—	—	4	—	—	1	—	3	—	—	—
L. salicis .	—	—	—	—	—	—	—	1	—	—	25	1	6	51	1	—	1	2	13	162	73	3	5	2	7	—	10	1	1	—
H. ferrugalis .	—	—	—	—	—	—	—	—	1	—	—	—	36	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
N. noctuella .	—	—	—	—	100	—	—	—	—	—	—	—	52	90	1	—	—	—	—	100	20	—	1	85	2	—	31	—	1	—

TABLE 4D.

	1910					1915					1920					1925					1930	
D. plexippus . .	1	—	—	—	—	—	1	2	1	—	2	—	—	3	—	—	3	—	1	2	1	2
N. antiopa . .	2	7	—	—	4	7	2	19	11	1	—	3	1	2	2	1	1	—	1	7	4	3
V. cardui . .	3	48	381	263	491	39	—	186	145	3	811	341	165	202	12	11	948	131	2,588	152	27	1,042
V. atalanta . .	6	86	473	113	718	254	33	1,433	314	343	1,828	1,004	85	310	458	4	155	335	417	156	458	92
A. lathonia . .	1	2	—	—	—	—	—	—	2	3	—	3	—	3	1	—	—	—	1	—	—	1
L. boeticus . .	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	9	—	—	—	—	—
N. semiargus . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C. croceus . .	—	21	227	1,170	12	33	1	361	5	44	642	51	803	55	38	5	26	117	2,588	72	159	297
C. hyale . . .	—	290	7	1	1	—	1	15	2	3	10	50	8	—	—	—	—	—	32	184	2	2
P. daplidice . .	—	—	1	1	—	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	1	—
P. napi . . .	1	290	52	120	7	40	133	169	247	600	87	124	5	66	7	20	262	1	1	3	—	—
P. rapae . . .	62	460	30	156	3	—	262	1,043	62	113	316	245	308	367	41	24	152	62	6	4	1,200	50
A. atropos . .	3	14	6	5	6	2	1	2	1	1	8	4	4	2	21	5	2	8	1	3	11	2
H. convolvuli . .	2	168	2	2	4	19	4	275	—	1	5	2	124	4	6	5	4	22	2	21	141	3
C. euphorbiae . .	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C. galii . . .	—	1	1	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—
H. celerio . .	1	1	—	4	1	—	—	1	—	—	2	—	2	1	1	1	2	—	1	—	—	1
D. nerii . . .	2	1	—	1	1	—	1	2	1	6	1	—	1	—	1	—	3	—	1	—	1	—
C. livornica . .	—	7	44	3	1	1	—	—	—	—	15	—	6	—	2	1	—	—	5	—	2	142
M. stellatarum . .	—	85	46	—	1	2	1	17	22	30	4	6	6	2	5	2	1	1	71	21	2	51
A. ipsilon . .	—	10	2	20	1	3	—	—	1	29	1	—	—	5	—	—	10	—	—	3	1	—
P. porphyrea .	—	2	8	25	—	3	—	—	—	32	—	—	—	5	8	—	—	—	1	10	—	10
L. unipuncta . .	—	1	3	—	—	—	—	—	—	—	4	—	3	—	—	—	1	1	146	—	—	1
L. vitellina . .	2	—	—	4	—	—	—	—	—	4	14	1	3	6	1	—	1	—	2	1	2	—
L. albipuncta . .	—	—	3	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—
L. l-album . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
C. ambigua . .	—	2	1	—	—	—	—	1	—	—	—	13	—	7	—	—	—	—	1	—	—	—
L. exigua . .	—	6	11	—	—	—	—	—	—	—	3	1	—	5	25	—	45	—	54	—	—	1
H. peltigera . .	1	—	2	2	—	—	—	—	1	—	11	—	1	3	1	—	2	—	22	—	1	13
H. armigera . .	—	2	—	—	—	—	—	—	—	—	—	—	1	—	—	—	3	—	1	—	—	—
P. gamma . .	1	525	54	17	225	10	—	70	—	2	348	152	—	8	3	1	8	263	505	22	85	1,016
C. fraxini . .	1	—	—	1	—	—	—	1	—	—	1	2	2	—	2	—	—	—	—	2	—	—
N. obstipata . .	—	1	6	6	1	—	—	—	—	—	—	—	7	—	—	—	4	—	12	3	—	—
R. sacraria . .	—	4	—	—	—	—	—	—	—	—	—	1	2	1	—	1	5	—	3	1	1	1
U. pulchella . .	—	—	—	2	—	—	—	—	—	—	—	3	2	10	1	—	—	—	—	3	5	—
L. salicis . .	—	—	2	3	2	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	1	1
H. ferrugalis . .	—	—	82	—	1	—	—	—	—	—	—	1	—	—	1	—	1	—	55	—	1	—
N. noctuella . .	—	3	58	2	—	20	—	—	—	—	40	—	—	—	—	—	10	2	1,570	—	—	106

year occurred in 1872, when there were 436 recorded. The next highest total was 47 in 1880. Here is a clear instance that although the number of observers has certainly increased since 1872, the records have not shown any corresponding increase, which suggests that a high proportion of the insects has been recorded, and that this number is largely independent of the number of observers. Even after 1931, when the S.E.U.S.S. began an intensive search for migrants, the records have not shown any increase.

The species has occurred in Britain throughout the 12 months, August and September being the peak months (Table 3). It is outstanding among the British migrant butterflies in that most of the records are from the eastern portion of Britain, from Orkney to the south coast of England, strongly suggesting that the migrations come from the east, perhaps from Scandinavia.

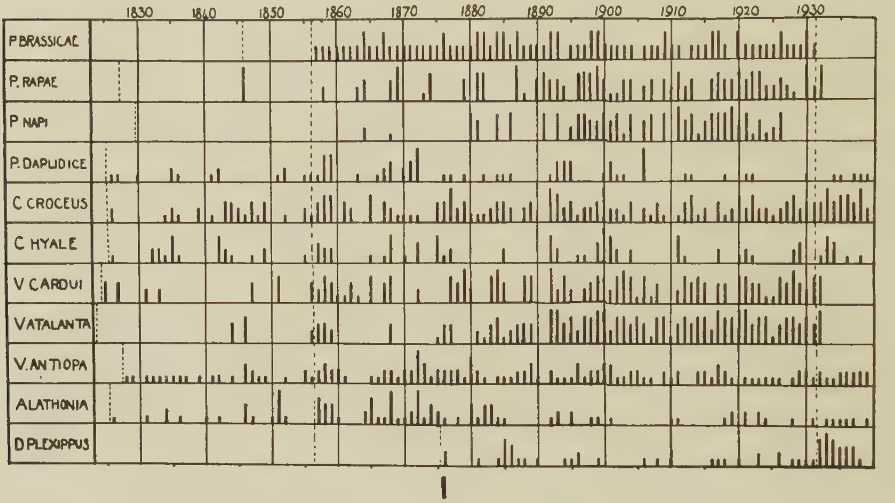

FIG. 1.—Annual abundance, in six grades, of British Immigrant Butterflies, 1824–1931.

Vanessa cardui (fig. 1).

The first records to come into this survey were in 1825. From that date to 1887 there were 30 years with no records, but since 1887 there has not been a year without mention of the species. It has occurred in all parts of Britain and in every month of the year (Table 3). There are, however, very few records during the winter months December to February. The grand total of records was 41,535 insects, and of these only 18 were reported in the winter months, in 11 out of 115 years. This is less than 1 in 2000 of the recorded individuals and even this probably represents too high a proportion, as " Painted Ladies " in winter are much more likely to attract attention than in summer. The summary of monthly totals, Table 3, shows two peak months, June and August, indicating that there are either two immigrations or that the second peak marks the brood resulting from the first immigration.

A contingency table giving the relation between " earliness " and " abundance " is shown in Table 5. The " early " migrants are considered as those occurring before June, and an " abundant year " is taken as being Grade 5 or 6.

In each square the observed results are to the upper left and the expected, on the hypothesis of no relation, to the lower right. In all subsequent contingency tables this arrangement will be followed.

The evidence shows that there were 31 years of abundance and 44 not abundant. Also, in 39 years the immigrants were early and in 36 they were late. If there were no correlation, in 16·1 years " abundant " would occur with " early," and in 21·1 years " late " would occur with " not abundant." The observed values show that " abundant and early " occur together in 23 years, and " late and not abundant " in 28, both considerably higher than the calculated. The values for " late and abundant " and " early and not abundant " are correspondingly lower than expected. The χ^2 test of significance calculated from these differences is 9·0, which gives a probability which is smaller than 0·01, a result which is certainly significant; otherwise, that there is less than 1 chance in 100 that this result has arisen by chance. The inference is that in any year early appearance of *V. cardui* would most likely be followed by a season of abundance, and that a late appearance would be followed by a season of small numbers.

Table 5.

Relation between earliness and abundance in *V. cardui* (1865–1939).

	Abundant	Not abundant	Total
Early . . .	23 16·1	16 22·9	39
Late . . .	8 14·9	28 21·1	36
Total . .	31	44	75

This result might be explained by assuming that Britain is on the fringe of the distribution area of *V. cardui*, the area of origin being north Africa. In years of abundance, the insects would spread farther afield more rapidly than in other years, and Britain would receive migrants earlier in the year, and would be well inside the fringe of the distribution area of the insect. As a result, the intensity of insects would be greater in such years. Also, the second brood, mainly homebred and dependent on the spring immigrations, would be increased by an early and abundant invasion.

Vanessa atalanta.

This is a regular migrant and has been recorded continuously with only a two-year gap since 1881. The relative abundance is shown in fig. 1.

For the period 1857–1931 there occur 19 years in Grade 5, 17 in Grade 4, and 19 in Grade 1. This last includes 13 years in which no records were found, which, however, cannot be taken to mean that no insects occurred as the species is generally common. If these years of no records are excluded from the total, it will be seen that the species occurs most frequently in intensity corresponding to Grade 4 and 5.

The annual totals in this species were arrived at by a process little short of guesswork. Its justification lies in the fact that the numbers obtained are not regarded in any way as being absolute and are used only for comparison of abundance. An arbitrary figure of 30 was taken to interpret such descriptive accounts as " common," " frequent " or " numerous," and 120 to interpret " abundant," " very common " or any such superlative description. If a numerical estimate were given, it was utilised. The totals so obtained did not give rise to any anomalous findings.

These arbitrary numbers were not included in the table of occurrences month by month (Table 3).

From 1824 to 1875 the butterfly was recorded in only 16 years, but since 1875 there were only 4 years when it was not mentioned. Since 1892, the annual totals have all been higher than the range of Grade 1. The records since this date would seem to be a truer estimate of the occurrences of the species.

Cyaniris semiargus.

The records of this insect are unusual in that the largest number reported in any year (20) was in 1825. It has only occurred in 25 years out of 115 (Table 4).

The majority of the records are for June, the range being from May to August (Table 3).

Cosmolyce boeticus.

This insect is another sporadic visitor. As shown in Table 4, it was recorded in 1859, and has been recorded in only 13 years since. The largest total taken in any year was 3, with the possibility that 9 were observed in 1926 since the records show the capture of three specimens in Torquay, Devon, in September and it was also seen there on six occasions during the month. The records are mainly from the south of England.

The numbers were not sufficiently large for the inclusion of this species in the correlations (see later).

Everes argiades.

This is a very rare visitor to Britain. Only seven records have been found. The first was that of two taken in 1874 at Frome, Somerset. These specimens, a male and a female, are now in the Dale Collection, Hope Museum, Oxford. This point is worth mentioning, since in 1885 three specimens were captured and were reported as being the first British specimens. The only other captures were in 1921 and 1931. The insect has been taken in Somerset, Dorset and Hampshire and in Sussex; four in August, one in September and two without information as to the month of capture.

This species has not been included in the correlations.

Argynnis lathonia (fig. 1).

The Queen of Spain Fritillary is about as frequent and as numerous as *P. daplidice.* The longest absence of records was the period of eight years between 1902 and 1910. The highest annual total was 50 insects in 1872 (Table 4). The records range from May to November, with August and September as the months of maximum abundance (Table 3). Most records are from South and South-east England, with a doubtful record in 1834 from Northumberland. One was reported from Scarborough in 1868.

Colias croceus (fig. 1).

The first record to come into this survey was that of a capture by B. Morris at Worcester in 1825. The following year it was taken in abundance at Charmouth, Dorset. In the period from 1825 to 1939, *i.e.* 115 years, there were only 15 years when the species was not recorded, and 15 years when it was abundant, that is, Grade 5 or 6. From fig. 1 it will be seen that the most frequent grade indices are 3 and 4, indicating that a medium abundance of this species is usual.

The species tends to be most abundant during August, as shown in Table 3, but has been reported as early as February in 1857 and 1935, and as late as December in 1878 and 1896. The rise in numbers to a peak in August indicates a steady influx of migrants culminating in the August abundances, rather than a spring invasion followed by a late summer invasion. The only years in which there is clear evidence of two distinct immigrations, or of one invasion and a local bred brood, were 1877 and 1938, in which cases about nine hundred more insects were recorded in June than in July, while in August the numbers recorded were over 5300 and 2400 respectively more than in July.

Table 6.

Relation between earliness and abundance in *Colias croceus*, 1830–1939.

	Abundant	Not abundant	Total
Early . . .	12 3·7	15 23·3	27
Late . . .	3 11·3	80 71·7	83
Total . .	15	95	110

An attempt was made to see if there was in this species any relationship between the appearance of early spring migrants and years of abundance. Early spring migrants were regarded as being those occurring before June, and years of abundance those indexed by 5 or 6. Table 6 shows a contingency table to illustrate the result.

In 110 years, from 1830 to 1939, there were 27 years with early immigrants and 83 with late, and 15 years of abundance and 95 of non-abundance. In the absence of correlation it would be expected that 15/110 of the "early" years would be abundant and 95/110 would be "not abundant." The expected totals are shown. χ^2 is 7·2 and is significant at 0·01 level. The observed totals of "early occurrence with abundant" and "late with not abundant" are significantly higher than the expected, and the observed totals of "late and abundant" and "early and not abundant" significantly lower. The inference is that early spring migrants are in general forerunners of a large immigration, and that a late appearance precedes a season with small numbers. Most of the records are from the south and south-east coasts and indicate that *C. croceus* arrives via France.

Colias hyale (fig. 1).

This species was recorded as being taken in 1826. Since that year it has appeared fairly regularly (see Table 4) but there have been several groups of years without records. Thus, from 1827 to 1830 inclusive, and from 1837 to 1841, 1850 to 1854, 1861 to 1864 (only 1 record), 1878 to 1884 (only 1 record), 1905 to 1910 (only 2 separate records), and 1923 to 1927, the species was not recorded. These periods of absence do not show any obvious periodicity. Grades 5 or 6 have occurred 9 times, and complete absence of records 45 times, out of the 114 years between 1826 and 1939. The species has been most abundant in Britain in August, and shows very little evidence of a double immigration (Table 3). In 1900 there were records of 36 insects in June, 15 in July, and 1758 in August. In 1901 there were 11 in June, 1 in July and 307 in August. Excluding these two years from the monthly summary, Table 3, it will be seen that the numbers show a steady increase from March and April (one record each) to August. There is one record of a capture as late as November in 1912.

TABLE 7.

Relation between earliness and abundance in *Colias hyale*, 1826–1939.

	Abundant	Not abundant	Total
Early . . .	3 0·8	7 9·2	10
Late . . .	6 8·2	98 95·8	104
Total . . .	9	105	114

The records are mainly from the south and south-east counties, and indicate that the insects come via France.

A contingency table, Table 7, was drawn up on the lines of that of *C. croceus* and shows that the figures observed are not very different from the calculated ones. The test for significance shows that $\chi^2 = 4{\cdot}4$, which is significant at 1 : 20 but not at 1 : 50. It is therefore possible, but not certain, that *C. hyale* appears earlier in its years of greater abundance.

Pontia daplidice (fig. 1).

This species, while never numerous in Britain, appears fairly regularly. The longest absence from Britain since 1826 (the first record collected) was the period of 8 years from 1844 to 1851. The total number of insects recorded between 1826 and 1939 was 366. This includes one record for 1906, where it was stated that over 200 were seen on the Dover cliffs. Apart from this, the highest annual total was 35 in 1872, the year when *N. antiopa* was also very abundant.

Most of the records are from south and south-east England. The most northerly was one in 1852 from Whittlesea Mere, near Liverpool. It is most likely that this insect arrives from France.

The monthly totals, Table 3, show that the earliest records were in May and latest in October, with August as the month when most occurred.

The Cabbage Whites.

The records of the three species *P. rapae*, *P. napi* and *P. brassicae* are complicated by the fact that they are normally present in numbers in Britain and tend to be reported only in the years of absence or of special abundance. In the case of *P. brassicae*, this is particularly noticeable.

Pieris brassicae (fig. 1).

The records of this species are not very reliable. In assessing the group indices of the years, the records were scanned, and were roughly placed in three categories : scarce, moderate and abundant, approximating to grades 2, 4 and 6. Any absence of records was regarded as indicating a moderate abundance. This method was not expected to be of great value, but on carrying out correlations with its related species, *P. rapae* and *P. napi*, it was found that the results obtained, although not as high as might be expected, were significant, and pointed to an observable fact that these species tend to be abundant together (see p. 257).

Pieris napi (fig. 1).

The records of *P. napi* are not of much use for this survey until 1880, since when they have been fairly consistent. Fig. 1 shows that the most frequent grades are 4, 5 and 6. If the 10 years without records are not counted, the preponderance of the higher grades is more obvious. The species occurs almost everywhere in Britain and apart from one record, in January 1860, appears to be limited to the period March to October, with a peak in August (Table 3).

Pieris rapae (fig. 1).

The records of *P. rapae* appear to be consistent since 1857, with the possible exception of 15 years in which there were no records (Table 4). It is very unlikely that in these years there were no *P. rapae* present.

The general abundance can be seen from fig. 1, which shows that if these 15 years without records are not considered, the Grades 3, 4 and 5 are the most frequent. The species has occurred in all months of the year, and all over Britain.

The Hawk-Moths (fig. 2).

The distribution of the hawk-moths in Europe suggests that the British migrants come from the Mediterranean region or from north Africa. Little information can be collected of their flight directions because most of the captures are taken at night over attractive flowers or at light, so that no positive evidence can be provided as in the case of *V. cardui* or *P. brassicae.*

Acherontia atropos (fig. 2).

This is one of the most regular British migrant hawk-moths. Since 1831 it has been unrecorded in only 17 years, and since 1857, in only 2 years. It has always been an insect which attracted attention and is usually recorded if seen by any naturalist.

A. atropos has occurred from March (1 specimen) until November, with September and October as the peak months (Table 3). There is a small secondary peak in June, which might suggest that there are two immigrations.

In this survey the larval and pupal stages have not been included. There have been more reports of larvae than of adults, but since the appearance of numbers of larvae throw little light on the numbers of the parents, they were omitted from this work. The most frequent grades are Grades 1 to 3, showing the tendency of the species to occur usually only in small numbers (fig. 2).

Herse convolvuli (fig. 2).

This hawk-moth has been reported in Britain with few intervals since 1824 (Table 4). It has been unrecorded in 14 years between 1824 and 1939.

It has occurred in all months except January, February and May, with September as the peak month (Table 3). The records of occurrences are distributed all over Britain with a preponderance in the south and south-eastern part of England.

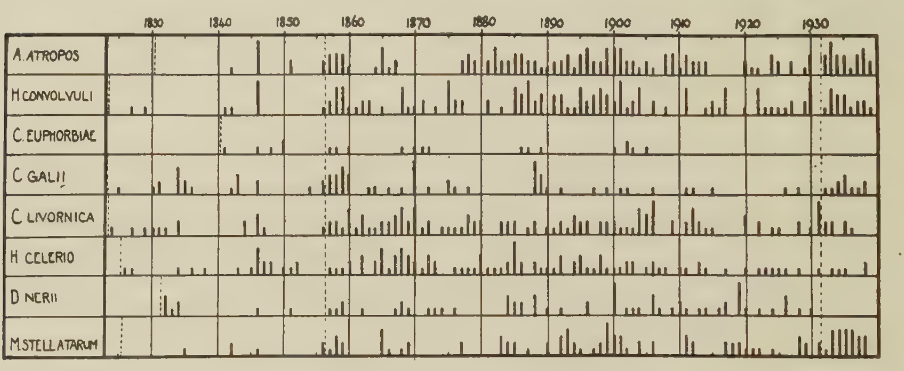

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Fig. 2.—Annual abundance, six grades, of British Immigrant Hawk-Moths (Sphingidae), 1824–1939.

From fig. 2 it can be seen that from 1857 to 1931 Grades 1, 2 and 3 were most frequent. In only three of these years was the species unrecorded. Although it is a very frequent visitor, it occurs in small rather than large numbers.

The records since 1931 show no marked difference from those of previous years, indicating that the numbers of insects recorded are not limited by the numbers of observers.

Celerio euphorbiae.

This species is a very rare visitor to Britain. From 1841 (the first record) to 1940, we have found records of only 11 adults and 33 larvae. The numbers were too small to include this species in the correlations given later. The months of occurrence of the adult are June to October, but 2 larvae were taken in March 1907. The records occur as far afield as Banffshire in Scotland, Cheshire, Norfolk and Somerset.

Celerio galii (fig. 2).

This species has been taken more frequently as a larva than as an adult. The first record since 1824 was one taken in 1825.

It has appeared at intervals since then for periods ranging from a single year to a maximum of seven years from 1854 to 1860, and eight years from 1932 to 1939. The largest number of adults recorded in any one year was 71 in 1870. There were also 17 larvae recorded in the year. In 1888, the species was again abundant, when 64 adults were recorded : in that year, over 1100 larvae were recorded. After the 1870 immigration none was recorded in 1871 and only one in 1872. After the 1888 immigration, when so many larvae occurred, there were 7 adults and 30 larvae recorded in 1889 and only 1 adult in 1890. It is possible that the 1888 immigration left progeny which became adult in 1889, but did not persist.

From Table 4 it can be seen that since 1857 it has been absent more frequently than present, and that in the years when it has occurred, 1 or 2 specimens is the most frequent number.

The species has occurred over Scotland and England. The adults have been most abundant in August, but have occurred from June to October. Apart from one record of 10 larvae in March 1892, the larvae and pupae have occurred also from June to October with peaks in August and September (Table 3).

D. galii is an example of a species that is capable of reaching Great Britain from Europe early enough in the year to produce a brood of larvae. The onset of winter, however, is so rapid that either the larvae do not reach maturity, or, reaching maturity, are unable to hibernate as adults.

Hippotion celerio (fig. 2).

Though not numerous, this species has occurred fairly frequently in Britain, and has been taken throughout the country, most of the records being from the south of England.

It has occurred in all months except January and February, with September as the month of maximum abundance (Table 3). Since 1857 there have been 20 years in which the species did not occur. The years of maximum abundance were 1865, with 27 insects, and 1885 with 41 insects (Table 4).

Fig. 2 shows that the most frequent grade is Grade 2, *i.e.* 1 or 2 individuals.

Daphnis nerii (fig. 2).

This hawk-moth has occurred sporadically in Britain as adult and larva. In 1832, four adults and two larvae were taken. It has been absent in 57 years out of the 100 years from 1832 to 1931, and the maximum total in any year is 6 in 1919. Occurrences of *D. nerii* have been reported from Aberdeenshire to Devonshire, including Lancashire, Yorkshire, Midlands, Norfolk and S. and S.E. England.

It has occurred from May to October, with September as the peak month (Table 3).

Celerio livornica (fig. 2).

This species has been fully dealt with by Grant (1937) and will not be discussed here except in its correlations with other species (p. 257).

Macroglossum stellatarum (fig. 2).

This has occurred in every month of the year, the period of maximum abundance being June to September with a slight peak in July. The appearance of the moth during the winter months suggests that in isolated cases it may survive throughout the winter. That it does not establish itself in any numbers after such hibernation can be inferred from the contingency table, Table 8.

This table tests the assumption that abundant years follow winters in which the moth occurred. Abundance is taken as being a year in which Grade 5 or 6 occurred, and winter is taken as being November, December, January and February.

TABLE 8.

Relation between years of abundance and records in the previous winter for *Macroglossum stellatarum*, 1865–1939.

	Abundant	Not abundant	Total
In winter . .	2 1·12	10 10·88	12
Not in winter . .	5 5·88	58 57·12	63
Total . .	7	68	75

The numbers are almost exactly what would be expected if there was no relation between abundance and appearance in the previous winter. There is an indication that years of abundance are followed by occurrences of the insects in the winter months as the following contingency table shows (Table 9). Years of abundance are compared with occurrences of the insects in the following winter months. The actual occasions when it occurred in winter are 5 and the expected, 1·1. The value of χ^2 is 13·4, which is highly significant. However, these numbers are too small for the result to be regarded as a proof.

TABLE 9.

Relation between years of abundance and records in the following winter for *M. stellatarum*, 1865–1939.

	Abundant	Not abundant	Total
In following winter .	5 1·1	7 10·9	12
Not in following winter .	2 5·9	61 57·1	63
Total . . .	7	68	75

There is a high proportion of Grade 1 as shown by fig. 2. In 19 years out of the 38 in Grade 1, the species was not reported. It can be seen that this species tends to occur more frequently in small numbers.

Noctuids.

Agrotis ipsilon (fig. 3).

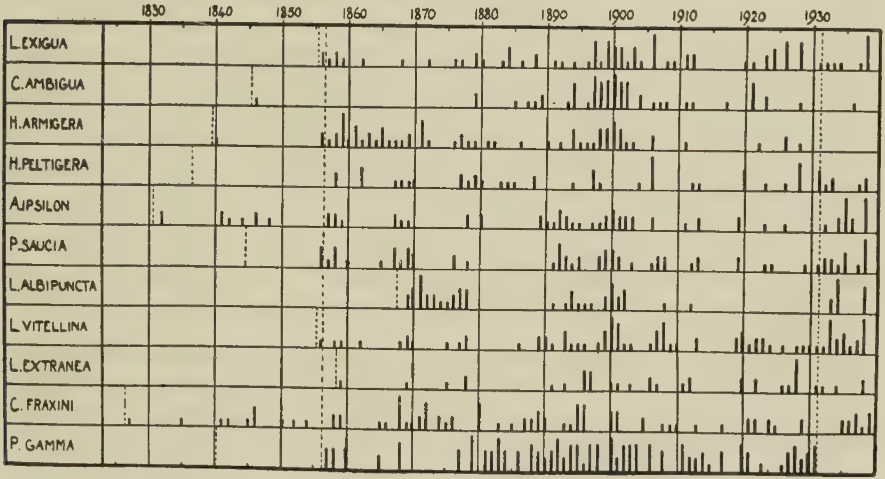
This insect is generally regarded as being native in Britain but supplemented by immigrations. The records show that it was found in 1831, and in the 109 years, 1831–1939, it has been recorded in 64 years, and has not been recorded in 45 years (Table 4).

The records reflect the activities of the South-Eastern Union of Scientific Societies in that, since 1931, they show two years of extreme abundance, greatly in excess of anything that had been previously recorded.

Well over half of the records are for August. The only months for which records were not obtained were January and December (Table 3).

Peridromia porphyrea (= *saucia*) (fig. 3).

This is an indigenous species that had not been reported in large numbers in Britain until 1938, when over a thousand insects were recorded. Since 1857, there has been a gap of 7 years in the records between 1882 and 1888, but apart from this the longest gap is 3 years. There is no evidence of a double peak in the monthly records. The month of greatest abundance is September (Table 3). It has occurred throughout Britain.



3

FIG. 3.—Annual abundance, in six grades, of British Immigrant NOCTUIDAE, 1824–1939.

Leucania unipuncta (= *extranea*) (fig. 3).

This is the " Army Worm " of America, where it does great damage to crops in some years.

The first record in Britain appeared in 1859. It has occurred sporadically since then, having been present in 24 years out of 81. There is little information in the records as to the months of maximum abundance. Table 3 shows that September has the highest total, but, since the year 1928 contributes over half of the September totals, most of those of October and November and all of those of December, not much can be inferred from the remaining years.

Captures are mainly from the south and south-west of England, from South Wales and the south of Ireland.

Leucania vitellina (fig. 3).

This species has occurred frequently but in small numbers since 1856 when it was first recorded in Britain. It has been present in 47 years and absent in 37 years. The years of greatest abundance were 1900, when 58 specimens were recorded, 1933 with 41 specimens and 1938 with 76 specimens.

The seasonal range is short. Apart from two records in 1869 and 1870, it has occurred in August, September and October only, with September as the peak month (Table 3).

On 26th September, 1938, 2 specimens were recorded flying to the south at the Sunk Light Vessel, off Felixstowe, Suffolk.

Leucania albipuncta (fig. 3).

The first certain record of this insect in Britain was that of a capture at Folkestone, Kent, in August 1868, although there is a report of one captured in " 1862 or 1864 at Yaxley " (? Hunts). The records show an unusual fluctuation (Table 11). From 1868 to 1879 the species occurred every year; from 1880 until 1890 there were no records; from 1891 until 1905 there were only two years in which it did not occur, and from 1906 to 1931 it occurred in only 4 years. Since 1931 it has occurred in 5 years, and has been unrecorded in 3 years, despite the activities of the Insect Immigration Committee of the S.E.U.S.S.

These gaps in the records are not explained by gaps in the occurrences of periodicals, which indicates that had there been occurrences during these years, there was no lack of observers or of opportunities for publishing observations.

It has occurred in Britain from June to October, the month of maximum abundance being August with 169 individuals and September with 84 (Table 3). There is evidence here of a single immigration arriving during the summer months and disappearing before winter.

The species has occurred mainly in south and south-east England, the most northerly record being one from the Norfolk Broads in 1895.

Leucania loreyi.

This is a very rare immigrant to Britain. Only six specimens have been recorded since 1862, when two were recorded in October. Two have been taken in September, three in October and the month of capture of the other was not given. The records are from Sussex, Devon and Co. Cork, Eire. The numbers recorded are too small to include in the correlation tables.

Leucania l-album.

Until 1933–1939, this rare immigrant had been recorded in only six years in Britain, the total number of insects being nine. Since 1932, this has been brought up to 264, of which one occurred in July, 256 in September, three in October and four were without the month being stated (Table 3). The records are mainly from the southern counties of England. This species also is not included in the correlation tables.

Caradrina ambigua (fig. 3).

In 1879 there was a record of four specimens being taken at Brighton which were said to be the first British specimens. However, a previous record existed of two specimens taken at Brixton in 1846.

Since 1879, it has been unrecorded in 36 years and present in 25 years. The maximum occurrences were in the years 1879 and 1900 (Table 4). During the period 1896 and 1902, it was recorded in several months during a year, but since then has been recorded in only one month of any year (Table 3). The earliest occurrence was in May and the last occurrence in October, with most in August.

All records in Britain are from the south coast, in the counties of Hampshire, Sussex and Kent.

Caradrina exigua (fig. 3).

This was first recorded in Britain in 1856 and has occurred at intervals since then. The longest unbroken series of records was for the 9 years from 1896 to 1904, and the next longest of 4 years from 1856 to 1859 inclusive (Table 4).

The sporadic occurrence strongly suggests that it is a migrant. The months of greatest abundance were August, September and October, with a peak in September (Table 3). Apart from the years 1906 and possibly 1938, there is no evidence of a double peak of abundance in the same year. In these two years, more insects were recorded in June than in July. Most of the records are from the south of England, but there are also records from Berwick and from Hartlepool.

Heliothis peltigera (fig. 3).

This has not appeared very frequently in the records. It was recorded in 1837. From then to 1939, a period of 103 years, it was present in 52 years and absent in 51 years. There are periods ranging from one to nine years when it was not recorded (Table 4). Larvae have been recorded in large numbers from May to September.

The monthly totals show a peak in June and another in September, and the species has occurred from January to October, though the January to March records are obtained from two years only (Table 3).

This species is able to produce a brood during the summer months, but there is very little evidence to show that it can maintain itself in Britain during the winter. There are no records of the larvae or pupae before July or after October. It would appear from the records that it should be regarded as a rare immigrant rather than as a resident.

Heliothis armigera (fig. 3).

This rare immigrant was first recorded in Britain in September 1840. It was not recorded again until 1856. From 1857 to 1903 it was absent in only 15 years, but from 1903 to 1939 it has been reported in only 5 years (Table 4). It was most abundant in 1859 when 28 specimens were recorded. The activities of the Insect Immigration Committee have not influenced the records in any way.

It has been seen as early as June in 3 years, as late as October in 8 years, and the months of maximum records are September and October (Table 3). There is no evidence of a double immigration.

The larva of *H. armigera* is the " Cotton Boll Worm " which damages corn and cotton crops in America and in Africa.

Plusia gamma (fig. 3).

This is a well-known migrant moth, and it has received much notice in the literature since 1879, when, together with *V. cardui*, it occurred in extreme abundance throughout Britain. Before 1879, it was mentioned in 9 years only, of which 3 years had a report of one specimen each (Table 4).

The records of *P. gamma* include many descriptive accounts of the numbers seen. The same system of transforming words into figures was used as for *V. atalanta*, where such terms as " very common," " abundant " and " swarming " were given the arbitrary figure of 120; " common," " very frequent " and " numerous " were given the figure of 30; whenever actual numbers were given they were used as given. Although this system is so arbitrary, it has provided a method of comparing abundances which appears to give consistent results. It has long been known to collectors that *P. gamma* is usually abundant when *V. cardui* is abundant. A correlation of the occurrences of these two species gives a result significant at the 0·01 level (see Table 33).

The monthly totals have been made up to 1932, after which the records became greatly increased owing to the activities of the S.E.U.S.S. These totals (Table 3) show that there are two peaks of abundance, one in May and June and the other in August and September. This fact could be explained either as a double immigration in the year, or as a spring immigration followed by the resulting summer brood. The occurrence of a preponderance of spring flights to the northward and of autumn flights to the south for the years 1933–1936 (Fisher 1938) strongly suggests that the double peaks are partly at least the result of a double migration.

The distribution of the " Silver Y " in Britain for the years 1933–1936 has been fully dealt with in a paper by K. Fisher (1938). It has been reported in all months of the year except January and February, but there are only two single captures in March (1879 and 1929); two years in which captures were recorded in April (1893 and 1903); and four years in which there were single captures in December.

The main season is therefore from May to October (Table 3). The relative abundance in the different years is shown in fig. 3. Grades 1 and 2 occurred in 35 years, of which 22 years were without records, and Grades 5 and 6 in 17 years. That is, the species was most abundant about half as frequently as it was least abundant.

Catephia alchymista.

This is extremely rare in Britain. It was first recorded in September 1858, since when it has occurred in only six years, the maximum number in any year being 3 in 1875. In July 1894 two larvae were taken at Eastbourne. Apart from these two instances, all the records have been of single occurrences. Six of the eight adults were recorded in June, and two in September. One record comes from Cleobury Mortimer in Shropshire, one from Essex and the rest from the south coast of England. This is undoubtedly an immigrant reaching England from France. The number of records is too small to include it in the correlations.

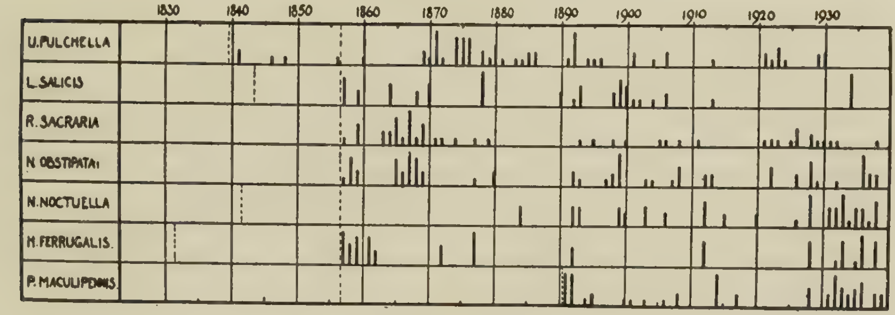
Catocala fraxini (fig. 3).

The first record to come into this survey was that of two captures in Kent in 1827. There were a few previous records in England. The records since then are quite regular but few in any year. The highest total in any year was 9 in the year 1868. After the 1827 record there was a gap of seven years before the next record in 1835. Since then, however, the longest gap without a record was five years. The longest unbroken period of occurrences was the six years 1885 to 1890 inclusive, taking into account the occurrence of two larvae at Southport in 1886 (Table 11).

It has occurred in July, August, September and October with a maximum in September (Table 3). It arrives in Britain in late summer, and does not become established.

Nycterosea obstipata (=*flaviata*) (fig. 4).

This insect has occurred in Britain in small numbers with frequent periods of absence. In the 75 years from 1857 to 1931 it has been unrecorded in 37 years, single specimens have occurred in 13 years, and the highest total for any year is only 23, in 1899. It has occurred in the months from May to November, and the months of maximum abundance are September and October (Table 3).



4

FIG. 4.—Annual abundance, in six grades, of certain British Immigrant Lepidoptera, 1824–1939.

Rhodometra (= *Sterrha*) *sacraria* (fig. 4).

The first record of this insect to be included was one taken in September 1857. It has occurred since then in 32 years out of 83.

The records of monthly totals (Table 3) show that most occur in August, and that the range is from April to October.

It has occurred throughout Britain, but is recorded mainly from the southern counties of England.

Utetheisa pulchella (fig. 4).

This is a rare migrant that has appeared in Britain at intervals for periods of from one to four years.

The first record is one taken in 1840. Since that date it has occurred in 36 years, and has been unrecorded in 64 years. The largest number reported in any year is 49 in 1892 (Table 4).

The seasonal range is from May to October, with one record for November. From Table 3 it can be seen that, although the numbers are small, there appears a definite peak in April and May, and another in September and October.

In Britain it has occurred mainly in the South of England, but has been taken as far north as Aberdeen. Blair (1925, *Entomologist* **58** : 5) has suggested that it might be resident in the Scilly Islands.

Leucoma salicis (fig. 4).

This insect is a resident in Britain but is reinforced at times by immigration. In June 1878, at Harwich, "thousands appeared . . . having crossed the sea. They resembled a fall of snow." At Salzburg, Germany, on 22nd August 1886, "millions were flying from N.E. to S.E. (sic) between 2 and 4 p.m."

Towards the end of August 1900, large numbers were observed about 10 miles off Flushing at about 5 a.m. All were flying to the north-west.

In early July 1929, an immigration was recorded at Southwold, Suffolk.

The occurrences of the moth are shown graphically in fig. 4. The maximum abundances occurred in 1878 and 1934.

It occurs as adults mainly in June, July and August, but in 1908 and 1912 single specimens were recorded in September and in 1933 one occurred in October.

Nomophila noctuella (fig. 4).

This species, although now recognised as a regular migrant, was not well recorded before 1931. Since then, however, very full reports have been collected. It has been noted particularly when it has occurred in abundance with *P. gamma* and *V. cardui*. It has occurred in all months except January, February, April and December, but only once in March, once in November and three times in October, so that the main period of occurrence is May to September, with a peak in August and September (Table 3).

It is fairly widespread in Britain. The only record of a definite flight direction was on 20th March 1935, at Round Island Lighthouse, Scilly Islands, when 6 or 7 were seen flying to the north.

Hapalia ferrugalis (fig. 4).

This is a migrant which is recorded in only 18 years between 1857 and 1931. Of these, single specimens have been recorded in 8 years. The highest totals occurred during the years 1857, 1877 and 1936, each with over 200 insects (Table 4).

It has occurred from May to November, with the peak months August and September (Table 3). It has been recorded mainly from the southern counties of England, but also in Scotland, the North of England and in Ireland. In August 1898 and in September 1930, numbers were taken at sea in the Mediterranean.

Plutella maculipennis (fig. 4).

This insect, "The Diamond-Back Moth," causes extensive damage at times to the crucifer crops in Britain. It has occurred sporadically in great swarms mainly along the east coast of Britain, from the Shetlands to Kent.

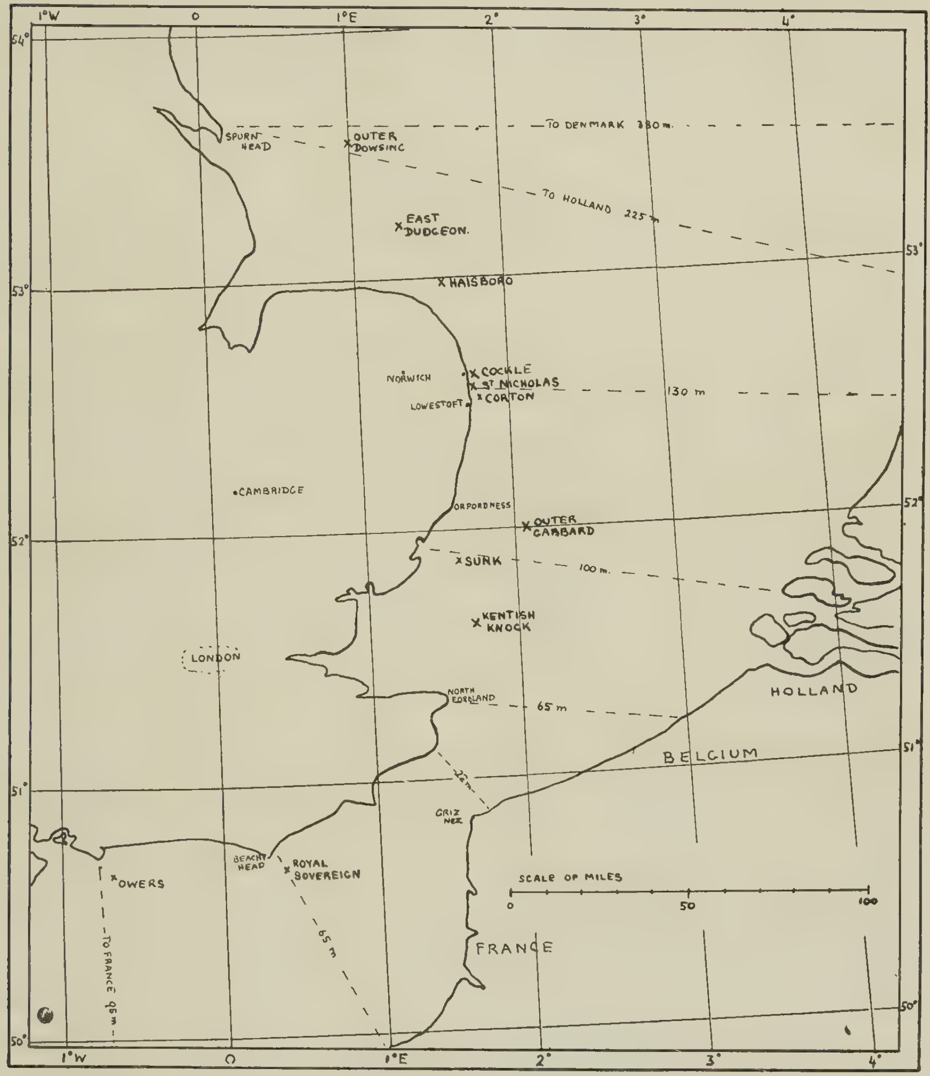
The records begin as late as 1891. Since then, it has been reported in 22 years. It is quite likely that, as it is not conspicuous, it becomes recorded only when it occurs in great abundance.

The records were almost entirely descriptive, those since 1931 have been in greater detail than those previous. It appears to occur from May to October, and most frequently in June and August. It has not been included in the correlations.

IV. Lepidoptera observed at lightships off the south and east coasts of England, 1932–1939.

By M. E. Gibbs.

The material available consists of records of Lepidoptera appearing at ten light vessels off the south and east coasts of England. Through the activities of the Insect Immigration Committee of the South-Eastern Union of Scientific Societies about three hundred and ninety records have been sent in by various


1°W
0
1°E
2°
3°
4°
54°
53°
52°
51°
50°
SPURN HEAD
OUTER DOWSING
TO DENMARK 380 m.
TO HOLLAND 225 m
EAST DUDGEON.
HAISBORO
NORWICH
COCKLE
ST NICHOLAS
CORTON
LOWESTOFT
130 m
CAMBRIDGE
ORFORDNESS
OUTER GABBARD
SURK
100 m.
KENTISH KNOCK
LONDON
NORTH FORELAND
65 m
HOLLAND
BELGIUM
22 m
GRIZ NEZ
BEACHY HEAD
ROYAL SOVEREIGN
OWERS
TO FRANCE 96 m
65 m
SCALE OF MILES
0
50
100
FRANCE

5

Fig. 5.—Map showing the position of the lightships from which records were received.

lightship keepers during the seven years 1932–1939, and these were passed on to Rothamsted for study.

The names and positions of the lightships are shown in the map (fig. 5) and in Table 10. The latter gives also the distance from the nearest land and the name of the observers. Our thanks are due to all those voluntary assistants, and to the officials of Trinity House who gave permission for their co-operation.

Naturally records collected in this way are fragmentary; only a few of the lightships assisted, and often some of our best observers were transferred to other localities. Therefore, the number of observations at any lightship cannot be taken as a measure of the comparative frequence of flights in that neighbourhood. However, the positive evidence obtained always holds good, and much of its value lies in the possibility of correlation with records on land.

TABLE 10.

List of lightships with their positions and the names of observers who sent in records.

Name	Contraction	Position	Observers
1. Outer Dowsing.	OD.	30 m. E. of Spurn Head, S. Yorks.	J. W. R. Reeve. H. Maylett.
2. East Dudgeon.	ED.	22 m. N.E. of Blakeney Pt., N. Norfolk.	S. G. Sharman. J. Audley. W. F. Fuller.
3. Outer Gabbard.	OG.	20 m. E.S.E. of Orfordness, S. Suffolk.	C. L. R. Turnor.
4. Haisboro'.	H.	11 m. E.N.E. of Cromer, Norfolk. 9 m. N.E. of Mundesley, Norfolk.	W. F. Willgress. F. England.
5. Sunk.	S.	10 m. S.E. of Felixstowe, S. Suffolk.	C. L. R. Turnor.
6. Royal Sovereign.	RS.	7 m. S.E. of Eastbourne, Sussex.	F. J. Morgan. S. G. Rowe.
7. Owers.	O.	7 m. off Selsea Bill, W. Sussex.	W. F. Willgress. H. G. Hollis.
8. Corton.	Cn.	3½ m. N.E. of Lowestoft, N. Suffolk.	S. G. Sharman. E. Bulley.
9. Cockle.	Ce.	2 m. E.N.E. of Yarmouth, Norfolk.	W. F. Willgress.
10. St. Nicholas.	St. N.	1 m. off Gorleston, S. Norfolk.	S. G. Sharman.

In most cases specimens have been sent in with the observations; whenever identification was doubtful the records have not been used. A source of inaccuracy more difficult to correct is that associated with the estimation of the numbers of insects present in a flight: for example, the term " several " has a wide scale of values and may easily vary in its meaning from one observer to another. Data concerning the direction of movement and that relating to the weather conditions are probably unusually accurate as such things help to make up the daily routine of the lightship keepers.

Altogether about 120 species of Lepidoptera have been recorded by the observers. Of these the majority only occurred on very few occasions and their presence may have been accidental. Table 11 shows 85 species which occurred only singly or on not more than three occasions. Of these only 7 (or 1 in 12) were previously considered as, or suspected to be, migrants; these are marked with an asterisk in the table. The others may be considered as possible migrants but a final decision must await further evidence.

TABLE 11.

List of Lepidoptera which were recorded on not more than three occasions at the lightships. * denotes previously considered as, or suspected to be, a migrant.

Rhopalocera.	
**Nymphalis antiopa*	H. 1936 Aug. 26. Cn. 1934 Aug. 21.
**Pieris napi*	Cn. 1935 Aug. 10; 1935 Aug. 22.
Pararge megera	OD. 1933 Aug. 20.
Maniola jurtina	RS. 1933 July 1.
Lycaena phlaeas	RS. 1933 Aug. 29.
Lycaenopsis argiolus	Cn. 1935 Aug. 10.
Polyommatus icarus	Cn. 1934 Aug. 16.
SPHINGIDAE.	
**Acherontia atropos*	OD. 1937 Sept. 23. St. N. 1932 Sept. 18.
**Macroglossum stellatarum*	S. 1938 Sept. 25. Cn. 1934 July 6.
**Herse convolvuli*	ED. 1932 Aug. 30. OG. 1939 Aug. 15.
Lathoe populi	Cn. 1935 July 1.
Mimas tiliae	Ce. 1935 June 30.
Bombyces.	
Leucodonta bicoloria	S. 1938 Aug. 24.
Lophopteryx capucina	H. 1934 Sept. 10.
Asphalia dilutata	Cn. 1934 Nov. 21.
**Leucoma salicis*	OG. 1939 Aug. 1.
Malacosoma neustria	S. 1938 Aug. 10.
Lasiocampa quercus	Ce. 1935 July 27.
Philudoria potatoria	S. 1938 July 19.
Gastropacha quercifolia	St. N. 1938 July 29.
Cilix glaucata	OD. 1935 Aug. 12.
Spilosoma lubricipeda	OG. 1939 July 11.
Spilosoma lutea	RS. 1933 July 12.
Eilema lurideola	Cn. 1935 Aug. 10.
NOCTUIDAE.	
Apatele rumicis	Ce. 1935 July 16.
Agrotis exclamationis	OD. 1935 Oct. 3. OG. 1939 July 8. Cn. 1935 July 1.
Euxoa nigricans	St. N. 1938 Sept. 24.
Euxoa tritici	OD. 1935 Aug. 24. Cn. 1935 Aug. 31.
Amathes xanthographa	OD. 1935 Sept. 5. Cn. 1935 July 23.
Diarsia rubi	S. 1939 June 11.
Triphaena comes	OD. 1935 July 6. S. 1938 Aug. 18.
Triphaena orbona	S. 1938 July 25.
Mamestra brassicae	RS. 1934 July 23.
Hadena trifolii	St. N. 1938 June 21.
Hadena bicruris	RS. 1933 Aug. 7. St. N. 1938 Sept. 27.
Apamea sordens	Cn. 1935, July 10.
Apamea secalis	OG. 1939 July 29.
Procus strigilis	RS. 1939 Aug. 19.
Actinotia polydon	St. N. 1938 Aug. 23.
Aporophyla australis	H. 1934 Aug. 19.
Nonagra typhae	H. 1934 Aug. 6.
Nonagra dissoluta	H. 1935 Aug. 12.
Arenostola pygmina	St. N. 1938 Aug. 29.
Arenostola phragmitidis	OD. 1935 July 23.
Leucanea pallens	OG. 1939 July 11.
Leucanea impura	St. N. 1938 Aug. 24.
Meristes trigrammica	St. N. 1937 June 16.
**Laphygma exigua*	S. 1938 Sept. 26.
Petilampa minima ?	RS. 1939 Aug. 23.
Amphipyra tragopoganis	OD. 1933 Aug. 25. S. 1938 Aug. 5.

NOCTUIDAE.	
Cosmia trapenzina	OG. 1939 July 7. S. 1937 Aug. 5; 1938 Aug. 11.
Agrochola pistacina	St. N. 1935 Oct. 1.
Cucullia asteris	RS. 1939 Aug. 16.
Scoliopteryx libatrix	S. 1937 Oct. 29.
GEOMETRIDAE.	
Comibeana pustulata	O. 1932 July 10.
Sterrha aversata	OD. 1934 July 18.
Scopula imitaria	OD. 1934 July 17.
Operophtera brumata	S. 1937 Nov. 24; 1938 Nov. 23; 1938 Dec. 12.
Lygris prunata	OG. 1939 July 13.
Lygris populata	OD. 1934 July 23.
Ephyia bilineata	OD. 1935 July 13.
Eupithecia centaureata	S. 1937 Aug. 5; 1937 Aug. 7; 1938 Sept. 6.
Cabera exanthemata	O. 1932 July 10.
Deuteronomos alniaria	OD. 1933 Aug. 15. Ce. 1935 Sept. 7. St. N. 1935 Sept. 26.
Selenia bilunaria	S. 1939 April 12.
Crocalis elinguaria	H. 1934 Aug. 21. RS. 1934 July 22.
Ourapteryx sambucaria	S. 1938 June 24; 1938 July 22. O. 1932 July 13.
Lycia hirtaria	H. 1934 May 12.
Cleora repandata	St. N. 1937 July 2.
Lithina chlorosata	ED. 1933 May 29.
Chiasmia clathrata	OD. 1933 July 18.
HEPIALIDAE.	
Hepialus humuli	Cn. 1935 July 10.
PYRALIDAE.	
Loxostege verticalis	OD. 1934 July 18; 1934 Aug. 4. S. 1938 Aug. 27.
Hydrocampa sp.	OD. 1935 Aug. 12.
Pyralis glaucinalis	OD. 1934 July 18; 1935 Aug. 17; 1935 Aug. 19.
CRAMBIDAE.	
Crambus sellasellus	OD. 1935 Aug. 19.
Crambus sp.	OD. 1935 July 19. ED. 1933 June 17. OG. 1939 July 13. Cn. 1935 Aug. 3.
TORTRICIDAE.	
Tortrix forsterana	OD. 1935 July 19.
Tortrix viridana	S. 1938 June 18; 1938 June 19. O. 1932 July.
Tortrix sp.	OG. 1939 July 19.
Cydia (Carpocapsa) pomonella	OD. 1935 Aug. 17.
Argyroploce salicella	OD. 1934 July 18.
Argyroploce striana	Cn. 1935 July 13.
TINEIDAE.	
Borkhausenia pseudospretella	OD. 1935 July 20.
Tinea sp.	OD. 1934 July 18.
Phthorimea instabillella	Cn. 1935 July 5.

Table 12 shows the 35 species which have occurred on more than three occasions or in considerable numbers on one or two days. Of these 13, or more than 1 in 3, were known or suspected migrants. The species are arranged in order of frequency of occurrence and the lightships in order of distance from land. It will be seen that 6 out of the 8 most frequently occurring species were known to be migrants; and that only 4 out of the 35 species did not occur in the first three light vessels, which are 20 miles or more from land.

TABLE 12.

List of Lepidoptera which occurred at least four times at the lightships; or if less than four times, at least on one occasion in considerable numbers.

	Total Records			Outer Dowsing			East Dudgeon			Outer Gabbard			Haisboro'			Sunk			Owers			Royal Sovereign			Corton			Cockle			Saint Nicholas		
	R	L	M	R	L	M	R	L	M	R	L	M	R	L	M	R	L	M	R	L	M	R	L	M	R	L	M	R	L	M	R	L	M
**Plusia gamma*	28	6	2	11	2	—	1	—	—	7	2	—	1	1	—	3	1	1	—	—	—	1	—	—	2	—	1	—	—	—	2	—	—
**Aglais urticae*	26	1	2	7	—	—	3	1	—	4	—	—	7	—	1	1	—	—	—	—	—	1	—	1	3	—	—	—	—	—	—	—	—
Phlogophora meticulosa	22	2	2	2	—	—	—	—	—	—	—	—	1	—	—	10	2	2	1	—	—	3	—	—	1	—	—	—	—	—	4	—	—
**Pieris rapae*	21	1	5	4	—	—	2	—	—	2	1	—	2	—	—	2	—	2	1	—	—	6	—	3	2	—	—	—	—	—	—	—	—
**Vanessa atalanta*	17	1	0	2	—	—	2	1	—	—	—	—	1	—	—	—	—	—	2	—	—	3	—	—	4	—	—	2	—	—	1	—	—
**Pieris brassicae*	17	8	5	4	1	1	3	3	—	1	1	—	—	—	—	—	—	—	1	1	—	4	—	3	1	1	—	1	—	—	2	1	1
Apamea monoglypha	15	2	1	3	—	—	—	—	—	3	2	—	1	—	—	2	—	—	—	—	—	1	—	—	4	—	1	1	—	—	—	—	—
**Agrotis segetum*	13	1	—	1	—	—	—	—	—	—	—	—	—	—	—	8	1	—	—	—	—	—	—	—	1	—	—	—	—	—	3	—	—
Euproctis similis	9	1	1	5	—	—	2	1	—	—	—	—	—	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Amathes c-nigrum	8	1	1	4	—	—	—	—	—	1	1	—	—	—	—	2	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Euproctis chrysorrhoea	7	1	—	3	1	—	—	—	—	2	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Triphoena pronuba	7	—	—	—	—	—	—	—	—	3	—	—	—	—	—	1	—	—	—	—	—	2	—	—	—	—	—	—	—	—	1	—	—
Abraxas grossulariata	7	1	—	2	—	—	1	1	—	—	—	—	—	—	—	1	—	—	2	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Crambus tristellus	6	3	—	6	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
**Callimorpha jacobaeae*	5	—	—	3	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Luperina testacea	5	—	—	1	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
**Nymphalis io*	4	—	—	1	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
**Vanessa cardui*	4	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Arctia caja	4	—	—	1	—	—	—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Peridroma porphyrea	4	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—
Rhizedra lutosa	4	1	—	1	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Opisthograptis luteolata	4	1	—	—	—	—	—	—	—	1	1	—	—	—	—	1	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Crambus hortuellus	4	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—
**Agrotis ipsilon*	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—
**Leucania vitellina*	3	2	—	—	—	—	—	—	—	2	2	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Crambus culmellus	3	1	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
**Plutella maculipennis*	3	1	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Omphaloscelis lunosa	2	1	—	1	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Xanthorrhoe montanata	2	1	—	—	—	—	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
**Lithosia quadra*	1	1	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Agrotis clavis	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cirrha gilvago	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sterrha emarginata	1	1	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Xanthorrhoe fluctuata	1	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hyponomeuta cognatellus	1	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

R = total records. L = large number. M = moderate numbers. * Denotes previously considered as, or suspected to be, a migrant.

TABLE 13.

The commoner Lepidoptera at the lightships arranged according to month of occurrence and locality.

Month	Insect	Outer Dowsing	East Dudgeon	Outer Gabbard	Haisboro'	Sunk	Owers	Royal Sovereign	Corton	Cockle	St. Nicholas
March	*P. gamma*	—	—	—	—	—	—	—	—	—	**38**, 29 (1)
April	*P. meticulosa*	—	—	—	**38**, 1 (2)	**38**, 18 (2)	—	—	—	—	—
May	*P. brassicae*	—	—	—	—	—	—	**33**, 24 (2)	—	—	**37**, 27 (100–150)
	P. rapae	—	—	—	—	**38**, 21 (12)	—	**33**, 24 (1)	—	—	—
	C. jacobaeae	**33**, 16 (1), 21 (1) **33**, 23 (5)	—	—	—	—	**33**, 29 (1)	—	—	—	—
	O. luteolata	—	—	—	—	—	**33**, 29 (2)	—	—	—	—
June	**P. brassicae*	—	—	—	—	—	—	—	**35**, 13 (M)	—	**37**, 5 (20–30)
	**P. meticulosa*	—	—	—	—	—	—	—	—	—	**38**, 24 (2)
	**P. gamma*	**35**, 2 (1)	**33**, 7 (6)	—	—	—	—	—	—	—	—
	X. montanata	—	**33**, 16 (2)	—	—	—	—	—	—	—	—
	**O. luteolata*	—	—	—	—	**39**, 16 (1)	—	—	—	—	—
	C. hortuellus	—	—	—	—	—	—	—	**35** (1)	—	—
	P. maculipennis	—	**33**, 9 (M)	—	—	—	—	—	**35**, 5 (1)	—	—
July	*A. urticae*	**35**, 27 (1)	—	—	—	—	—	—	—	—	—
	N. io	**33**, — (1)	—	—	—	—	—	—	—	—	—
	V. atalanta	—	**33**, end (M)	—	—	—	—	—	—	—	—
	**P. brassicae*	**33**, 27 (1)	**32**, 3 (M)	—	—	—	**37**, 28 (H)	**39**, 11 (12)	—	**35**, 16 (1)	—
	**P. rapae*	—	**32**, 3 (M) **33**, 22 (2)	**39**, 19 (4)	—	—	— **32**, 23 (2)	—	—	—	—
	E. chrysorrhoea	**34**, 18 (1 + M) **34**, 20 (6) **34**, 24 (1)	—	—	**34**, 20 (6)	—	—	—	**35**, 10 (1) **35**, 16 (1)	—	—
	E. similis	**33**, 27 (1) **35**, 24 (1) **35**, 28 (1)	**33**, 20 (2) **33**, end (M)	—	—	**38**, 26 (12)	—	**33**, 27 (1)	—	—	—
	A. caja	—	—	—	**36**, 25 (2)	**37**, 19 (2)	—	—	—	—	—
	T. pronuba	—	—	**39**, 1 (4)	—	—	—	—	—	—	—
	L. testacea	**34**, 30 (1)	—	**39**, 26 (2)	—	—	—	—	—	—	—
	A. monoglypha	**32**, 26 (1) **34**, 16 (1)	—	**39**, 15 (D) **39**, 23 (S)	**34**, 16 (S)	—	—	**34**, 23 (1)	**34**, 14 (20) **35**, 5 (1) **35**, 6 (1)	—	—
	L. vitellina	—	—	**39**, 7 (1) **39**, 15 (D) **39**, 27 (D)	—	—	—	—	—	—	—
	**P. gamma*	**35**, 26 (1) **36**, 18 (1) **36**, 19 (1)	—	**39**, 5 (6)	—	—	—	**34**, 22 (2)	**34**, 26 (12)	—	—
	**X. montanata*	—	**33**, end (M)	—	—	—	—	—	—	—	—
	A. grossulariata	**33**, 24 (3)	**33**, end (M)	—	—	—	**32**, 9 (1) **32**, 10 (1)	—	—	—	—
	C. culmellus	**33**, 25 (1) **34**, 18 (2) **34**, 20 (4 +)	—	—	—	—	—	—	**35**, 13 (M)	—	—
	**C. hortuellus*	**34**, 18 (1) **35**, 23 (S)	—	—	—	—	—	—	**35**, 10 (2)	—	—
	C. tristellus	**35**, 15 (S) **35**, 22–24 (M)	—	—	—	—	—	—	—	—	—

Aug.	**A. urticae*	**33**, 3 (1) **34**, 3 (1) **34**, 15 (2) **34**, 17 (1) **35**, 11 (1)	**33**, 2 (M) **33**, 20 (2) **33**, 21 (1)	**39**, 13 (S) **39**, 21 (S) **39**, 26 (2) **39**, 31 (1)	**32**, 1 (1 + S) **34**, 3 (1) **34**, 15 (1) **34**, 17 (12) **36**, 26 (1)	—	—	**39**, 27 (20)	**34**, 16 (1) **35**, 24 (1)	—	—
	**N. io*	—	—	**39**, 13 (S) **39**, 21 (S)	—	—	—	—	—	—	—
	V. atalanta	**33**, 22 (5) **33**, 30 (1)	**33**, 21 (1)	—	**33**, 22 (2)	—	—	**33**, 22 (1) **39**, 25 (8)	**35**, 22 (2) **35**, 31 (3)	**35**, 1 (1) **35**, 24 (1)	—
	V. cardui	**33**, 2 (1)	—	—	—	—	—	—	—	—	—
	**P. brassicae*	**33**, 2 (20) **34**, 18 (1) **36**, 20 (M)	**33**, 2 (M)	**39**, 12 (D)	—	—	—	**39**, 6 (S) **39**, 16 (1)	—	—	—
	**P. rapae*	**32**, 6 (1) **32**, 18 (1 +) **34**, 8 (1) **34**, 18 (1)	—	**39**, 12 (D)	**34**, 1–4 (5) **36**, 20 (1)	**37**, 14 (20)	—	**33**, 30 (20+1) **39**, 6 (S) **39**, 16 (20)	**35**, 22 (2) **35**, 23 (1)	—	—
	**E. chrysorrhoea*	**34**, 4 (M)	—	—	**32**, — (S)	—	—	**33**, 7 (1)	—	—	—
	**E. similis*	**35**, 11 (1) **35**, 19 (2)	—	—	—	—	—	—	—	—	—
	**A. caja*	**33**, 2 (1)	—	—	**32**, 4 (2)	—	—	—	—	—	—
	L. quadra	—	—	**39**, 21 (D)	—	—	—	—	—	—	—
	A. segetum	**35**, 24 (3)	—	—	—	**38**, 27 (4) **39**, 29 (S)	—	—	**35**, 30 (3)	—	—
	P. porphyrea	—	—	—	—	—	—	**33**, 27 (2)	—	—	—
	A. c-nigrum	**33**, 14 (1) **35**, 24 (1)	—	—	—	—	—	—	—	—	—
	**T. pronuba*	—	—	**39**, 14 (1)	—	**38**, 7 (2)	—	—	—	—	—
	**L. testacea*	—	—	—	—	**38**, 22 (2) **38**, 28 (S) **38**, 29 (S)	—	—	—	—	—
	**A. monoglypha*	**34**, 16 (1)	—	**39**, 7 (D)	—	—	—	—	**34**, 17 (5)	—	—
	**P. meticulosa*	—	—	—	—	**38**, 8 (D) **38**, 9 (D) **38**, 29 (S)	—	**33**, 27 (1)	**35**, 31 (2)	—	—
	**P. gamma*	**34**, 23 (1) **35**, 18 (1) **35**, 19 (1) **35**, 20 (1) **35**, 24 (2) **36**, 20 (H & T) **36**, 21 (M)	—	**39**, 21 (D) **39**, 14 (S) **39**, 23 (S) **39**, 25 (S) **39**, 31 (S)	**38**, 8 (D)	**38**, 8 (D) **38**, 9 (D) **38**, 24 (12)	—	—	—	—	—
	S. emarginata	**36**, 20 (M)	—	—	**33**, 6 (M), 18 (S)	—	—	—	—	—	—
	X. fluctuata	—	—	—	—	—	—	—	—	—	—
	**A. grossulariata*	—	—	—	—	**38**, 6 (2)	—	**39**, 24 (1)	—	—	—
	**O. luteolata*	—	—	**39**, 21 (D)	—	—	—	—	—	—	—
	**C. tristellus*	**35**, 6 (M) **35**, 11 (S) **35**, 24 (M) **36**, 20 (M)	—	—	—	—	—	—	—	—	—

The first figure (**heavy type**) is the year; the second the date of the month; the third (in brackets) the numbers stated to have been seen. S = several, D = dozens, M = many, H = hundreds, T = thousands. * = previously mentioned in the same table.

TABLE 13 (*Continued*).

Month	Insect	Outer Dowsing	East Dudgeon	Outer Gabbard	Haisboro'	Sunk	Owers	Royal Sovereign	Corton	Cockle	St. Nicholas
Sept.	**A. urticae*	**35**, 5 (1)	—	—	**36**, 8–12 (1)	**37**, 3 (6)	—	—	**34**, 12 (3)	—	—
	**V. atalanta*	—	—	—	—	—	**33**, 25 (1) **33**, 30 (5)	**33**, 2 (1) **39**, 8 (1)	**34**, 6 (2) **34**, 20 (2)	—	—
	**V. cardui*	—	—	—	—	—	**33**, 30 (1)	—	—	—	—
	**P. rapae*	—	—	—	—	—	—	**39**, 8 (3)	—	—	—
	**A. segetum*	—	—	—	—	**38**, 2 (2) **38**, 6 (3) **38**, 14 (3) **38**, 23 (H)	—	—	—	—	**38**, 4 (2) **38**, 19 (1) **38**, 27 (3)
	A. clavis	—	—	—	—	**38**, 23 (H)	—	—	—	—	—
	A. ipsilon	—	—	—	—	**38**, 23 (H)	—	—	**34**, 8 (1)	—	**38**, 20 (8)
	**P. porphyrea*	—	—	—	—	**38**, 23 (H)	—	—	—	—	**38**, 27 (3)
	**A. c-nigrum*	**34**, 1 (1) **34**, 4 (1)	—	—	—	**37**, 5 (20–30) **38**, 2 (2)	—	— **34**, 15 (1)	**34**, 1 (6)	—	—
	**T. pronuba*	—	—	—	—	**37**, 5 (20–30)	—	**39**, 7 (1)	—	—	—
	**P. meticulosa*	—	—	—	**34**, 8 (1)	**37**, 9 (12) **38**, 14 (3) **38**, 17 (1) **38**, 23 (H)	**33**, 26 (1)	**33**, 3 (1)	—	—	—
	R. lutosa	—	—	—	—	**38**, 23 (H) **38**, 26 (2)	—	—	—	—	—
	**L. vitellina*	—	—	—	—	**38**, 26 (1)	—	—	—	—	—
	O. lunosa	—	—	—	—	**38**, 23 (H)	—	—	—	—	—
	C. gilvago	—	—	—	—	**38**, 23 (H)	—	—	—	—	—
	**P. gamma*	—	—	—	—	**38**, 17 (1)	—	—	**34**, 5 (3)	—	—
	**O. luteolata*	—	—	—	—	—	—	**33**, 2 (1) **32**, 4 (1)	**34**, 12 (2)	—	— **35**, 7 (3)
Oct.	**V. atalanta*	—	—	—	—	—	—	—	—	—	—
	**P. rapae*	—	**33**, 4 (1)	—	—	—	—	—	—	—	—
	**A. segetum*	—	—	—	—	**38**, 20 (2) **38**, 25 (1)	—	—	—	—	—
	**A. ipsilon*	—	—	—	—	—	—	—	**34**, 16 (S)	—	—
	**P. porphyrea*	—	—	—	—	—	—	—	—	—	**35**, 12 (1)
	**P. meticulosa*	**35**, 5 (1) **35**, 27 (1)	—	—	—	**37**, 18 (4) **38**, 25 (1)	—	**33**, 5 (1)	—	—	**35**, 1 (1) **35**, 12 (1)
	**P. gamma*	**35**, 2 (1)	—	—	—	—	—	—	—	—	—
	**O. lunosa*	**35**, 3 (1)	—	—	—	—	—	—	—	—	—
	**R. lutosa*	**35**, 5 (1)	—	—	—	—	—	—	—	—	—

On the whole the species in this table must be considered as likely to be regular migrants, and this applies particularly to the noctuids *P. meticulosa* (see also p. 141) and *A. monoglypha*, both of which occurred on more than ten occasions.

One of the most unexpected species to be high up in the list is the geometrid moth *Abraxas grossulariata*, which occurred on seven occasions. On only one of these was any number present, but three records were over 20 miles from land. We are not aware that there had been any previous suggestion of migration in this insect.

It is interesting to note that of the six butterflies included in Table 12 all were previously known as migrants. The new suspected species are all moths about which our knowledge of possible movements is at a much lower level.

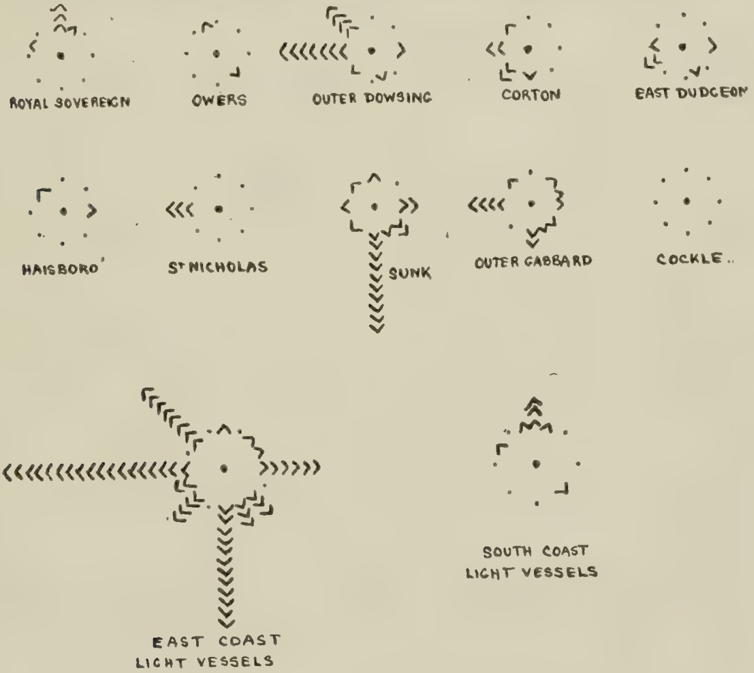


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Fig. 6.—Compass direction of the flights observed at the different lightships. North at the top of the page.

Table 13 shows the more common migrants listed according to their seasonal distribution, with the lightships at which they were reported. There are 9 occurrences of 4 species in May, and 10 of 8 species in June. In July activity increases rapidly with 61 records of 18 species, and reaches its maximum in August with 109 records of 23 species. In September activity falls off to 48 records of 17 species and again in October to 17 records of 9 species.

Finally Table 14 shows further details of the larger flights arranged under the species concerned, with the time of day, numbers present, wind direction and notes.

Altogether there are 88 records of occurrences of more than five insects at a time, on which either the direction of flight, or the direction of wind, or both, was given by the observer. These have been analysed in figs. 6, 7 and 8.

Fig. 6 shows the compass directions of the flights recorded at each of the

TABLE 14.

Particulars of the larger swarms arranged according to species, with direction of flight, wind and nearest land.

Date	Light Vessel	Time	Number	Flight	Wind	Direction nearest land	Remarks
Aglais urticae							
1933, Aug. 2	East Dudgeon	7.15 p.m.	Swarms	S.S.E.	Calm	22 m. S.W.	With *P. brassicae.*
Vanessa atalanta							
1933, July end	East Dudgeon	—	Many	—	S.W. or calm	22 m. S.W.	With *E. similis*, *X. montanata* and *A. grossulariata.*
Pieris brassicae							
1931, June mid	East Dudgeon	Noon to dark	30 per hour	W.	—	22 m. S.W.	
1932, July 3	"	2–5 p.m.	6 at a time	W. or S.W.	S.E. or calm	22 m. S.W.	No hurry. Numbers dwindled till none at 5 p.m.
1933, Aug. 2	"	7.15 p.m.	Swarms	S.S.E.	Calm	22 m. S.W.	With *V. urticae*
1933, Aug. 2	Outer Dowsing	5–6 p.m.	20	E.	W.	30 m. W.	Flying very fast.
1934, May 27	St. Nicholas	9 a.m.–6 p.m.	100–150	W.	W. or S.W.	1 m. W.	Thin but continuous. Cloudy and squally.
1934, June 5	"	10 a.m.–3 p.m.	20–30	W.	S.W. or W.	1 m. W.	Thin but undoubted migration, most about noon. Fair weather.
1935, June 13	Corton	—	Dozens	W.	—	3½ m. S.W.	
1936, Aug. 20	Outer Dowsing	—	Swarms	—	—	30 m. W.	Many on water.
1937, July 28	Owers	11 a.m.–1 p.m.	Hundreds	N.N.W.	S.E.	7 m. N.	
1939, July 11	Royal Sovereign	—	12	N.	—	7 m. N.W.	
1939, Aug. 12	Outer Gabbard	4 p.m.	Dozens	S.E.	N.W.	—	
Pieris rapae							
1933, Aug. 20	Royal Sovereign	4 p.m.	20	—	N.N.E.	7 m. N.W.	Settled on lantern.
1937, Aug. 14	Sunk	3 p.m.	20	S.	N.W	10 m. N.W.	
1939, Aug. 6	Royal Sovereign	—	A few	W.?	W.	7 m. N.W.	With *P. brassicae*—a few of each.
1939, Aug. 12	Outer Gabbard	—	Dozens	S.E.	N.W.	20 m. W.N.W.	With *P. brassicae.* Clear and sunny.
1939, Aug. 16	Royal Sovereign	—	20	—	S.E.	7 m. N.W.	With one *P. brassicae.*
Euproctis similis							
1933, July end	East Dudgeon	—	Many	—	S.W. or calm	22 m. S.W.	With *V. atalanta* etc., sea full of butterflies.
Euproctis chrysorrhoea							
1934, July 18	Outer Dowsing	6–9 a.m.	Many	W. and W.N.W.	S.E.	30 m. W.	With *S. aversata*, *L. verticalis*, *P. glaucinalis*, *C. pomonella*, *A. salicella*, *H. cognetella*, *Tinea* sp.
Lithosia quadra							
1939, Aug. 21	Outer Gabbard	—	Dozens	S.	E.	20 m. W.N.W.	With *A. c-nigrum*, *P. gamma* and *O. luteolata.*
Apamea monoglypha							
1939, July 15	Outer Gabbard	9 p.m.	Dozens	W.	S.E.	20 m. W.N.W.	With *L. vitellina.*
1939, July 23	"	2 a.m.	Several	N.E.	W.	"	
1939, Aug. 7	"	7 p.m.	Dozens	E.N.E.	W.S.W.	"	

Date	Light Vessel	Time	Number	Flight	Wind	Direction nearest land	Remarks
Phlogophora meticulosa							
1937, Sept. 5	Sunk	5 a.m.	20–30	S.	N.W.	10 m. N.W.	With *A. c-nigrum*.
1937, Sept. 9	,,	5 a.m.	12	S.	N.W.	,,	
1938, Aug. 8–9	,,	4–8 a.m.	Dozens	W.	E.	,,	With *P. gamma*.
1938, Aug. 29	,,	4–8 a.m.	Several	S. or S.E.	N.N.W.	,,	With *L. testacea* and *A. segetum*.
1938, Sept. 23	,,	2–7 a.m.	Hundreds	S.E.	N.W.	,,	With *A. segetum* (q.v.) and other NOCTUIDAE.
Leucania vitellina							
1939, July 15	Outer Gabbard	9 p.m.	Dozens	W.	S.E.	20 m. W.N.W.	With *A. monoglypha*.
1939, July 27	,,	—	Dozens	—	—	—	
Agrotis segetum, *A. clavis*, *A. ipsilon*, *P. porphyrea*, *R. lutosa*, *O. lunosa*, *C. gilvago* and *P. meticulosa*							
1938, Sept. 23	Sunk	—	Hundreds	S.E.	N.W.	10 m. N.W.	
Amathes c-nigrum							
1939, Aug. 21	Outer Gabbard	—	Dozens	S.	E.	20 m. W.N.W.	With *L. quadra*, *P. gamma* and *O. luteolata*.
Plusia gamma							
1936, Aug. 8	Haisborough	8 a.m.–7 p.m.	Dozens	N.W.	N.N.W.	9 m. S.W.	With *A. secalis*.
1936, Aug. 20	Outer Dowsing	4 a.m.	Thousands	W.	—	30 m. W.	With *P. brassicae*, *X. fluctuata* and *C. tristellus*.
1936, Aug. 21	,,	All night	Swarms	—	—	—	Largest flight ever seen by observer. Hundreds on water and dozens on board.
1939, Aug. 21	Outer Gabbard	8 a.m.–10 p.m.	Dozens	S.	E.	20 m. W.N.W.	With *L. quadra* (q.v.) etc.
Sterrha emarginata							
1933, Aug. 6	Haisborough	—	Thousands	—	S.E.	9 m. S.W.	On ship and on sea.
Xanthorrhoe montanata and *A. grossulariata*							
1933, July end	E. Dudgeon	—	Swarms	On sea	Calm	22 m. S.W.	With *V. atalanta* and *E. similis*.
Xanthorrhoe fluctuata							
1935, Aug. 20	Outer Dowsing	—	Swarms	On sea	—	30 m. W.	With *P. brassicae*, *P. gamma* and *C. tristellus*.
Opisthograptis luteolata							
1939, Aug. 21	Outer Gabbard	—	Dozens	S.	E.	20 m. W.N.W.	With *A. c-nigrum*, *L. quadra* and *P. gamma*.
Crambus culmellus							
1935, July 13	Corton	—	Many	—	E.	3 m. S.W.	
Crambus tristellus							
1935, July 22–24	Outer Dowsing	—	Many	N.W.	—	30 m. W.	Also several on 15th, 18 flying low.
1935, Aug. 6	,,	2–12 p.m.	Many	N.W.	Calm	,,	Also several on 11th, flying west 12–4 a.m.
1935, Aug. 22–24	,,	—	Many	N.W.	N.E.	,,	Migration in large numbers for 2–3 days.
1936, Aug. 20	,,	4 a.m.	Swarms	—	—	,,	On water. With *P. brassicae*, *X. fluctuata* and *P. gamma*.
Plutella maculipennis							
1933, June 9	East Dudgeon	Noon	Swarms	—	—	22 m. S.W.	All over the ship.

ten lightships and also a general summary for those off the east coast and those off the south coast. The former records are predominantly to north, northwest and south (see below). The latter are very few in number and chiefly towards the north.

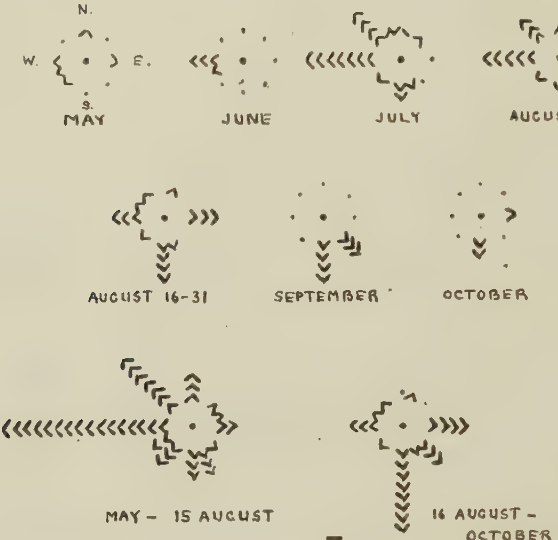

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Fig. 7.—Directions of flights observed at the different lightships according to the month of occurrence.

Fig. 7 shows the same records analysed according to month. They range from May to October, with a maximum of 31 flights in August. It was decided to divide August into two periods as there appeared to be a change in direction of flights during this month. The summaries from May to mid-August

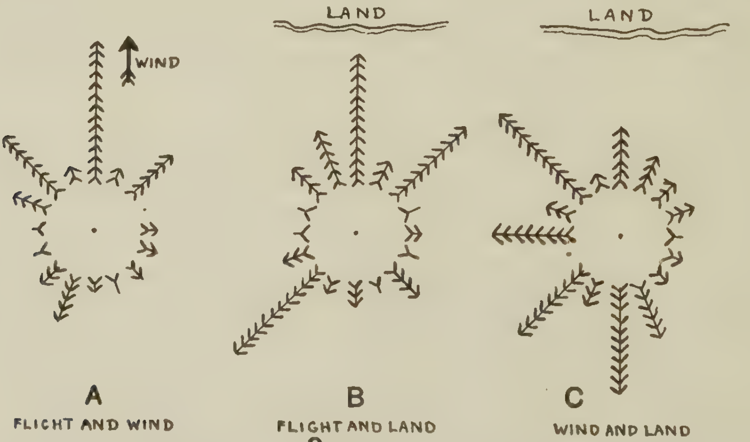

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Fig. 8.—Direction of flights observed at lightships in relation to wind and land:—A. Angle between flight and wind; B. Angle between flight and nearest land; C. Angle between wind and land at time of flight.

and from mid-August to October show a quite definite change of direction from predominantly west and north-west in the first period to towards the south, south-east and east in the second.

Fig. 8 shows an analysis of the same flights in relation to the direction of the wind, and the nearest land. Fig. 8, A, indicates that there have been distinctly more records of flights with the wind than against it. Fig. 8, B, seems to suggest a slight preference for the insects to fly towards the land, but the preponderance is not definite. Fig. 8, C, indicates that the flights are not more frequently recorded with a wind on or off shore. The apparent asymmetry of this figure is probably due to the presence of prevailing winds in one direction along the shore.

Previous records at British light vessels.

W. Eagle Clark, a great student of the migration of birds, made some observations on the presence of insects at light vessels.

In 1901 on Eddystone Lighthouse, situated 10 miles south-south-west of Rame Head near Plymouth, he recorded as follows (1904, *Ent. mon. Mag.* **40** : 9–10) :—

" 23rd September, *Agrotis segetum* (1).

" 1st October; 10 p.m. to 2 a.m. (on 2nd); Many hundreds of moths, of which captured specimens included *A. ypsilon*, *A. segetum* and *H. meticulosa.* Wind west light to calm.

" 12th October; Moths present in great numbers including *H. meticulosa*, *A. ypsilon*, *A. segetum* and *P. gamma.*

" 6th November; *H. meticulosa.*"

He adds : " *H. meticulosa* appears to be the greatest traveller, it was not only the most abundant species observed but also the most frequent visitor."

Again in 1903 on the Kentish-Knock light vessel, which is in the mouth of the Thames 21 miles north-east of Margate, Kent, and 21 miles south-west of the Naze, Essex (see fig. 5), he records (1903, *Ent. mon. Mag.* **39** : 289) numbers of *V. cardui* and *P. gamma* from 8.45 p.m. to midnight on the night of 22nd September. On the 28th September specimens of *E. alniaria* and *A. testacea* were also captured.

It will be seen that all his species are on our list and that there is still greater evidence for considering *P. meticulosa* as a migrant.

Records of insects at the lightships and lighthouses in Scotland.

In 1914, 1915 and 1916 W. Evans published a full account of insects captured at certain Scottish lighthouses over a period of about six years. Thirteen lighthouses sent in material and of these seven were in or near the Firth of Forth; the others were on the south-west coast, in the Hebrides, and in the Orkneys and Shetlands. Over 6000 specimens were examined and identified to 164 species of Lepidoptera.

Unfortunately this wealth of material does not throw much light on the subject of migration as nearly all the lights were either on the mainland or, if not, on the islands quite close to the coast or large enough to have their own resident fauna.

For example 101 species are recorded from the Isle of May in the Firth of Forth, about five miles from the Fifeshire coast and nine miles from the East Lothian coast. But the island itself is nearly one mile long and has quite a considerable vegetation.

The only light to which captures must have flown some considerable distance is the Bell Rock, which is off the Firth of Tay about 11 miles south-east of the coast of Forfarshire. At this light only 4 species were recorded: *X. monoglypha.* 1 male on 12th July 1915. *C. quadripunctata.* 1 male on 10th July 1915. *P. gamma.* 1 male on 8th July 1914. *P. maculipennis.* A "rush of small moths" believed to be this species in August 1914, but no specimens were kept for identification.

Of these, only *C. quadripunctata* is not on our list of captures.

V. OBSERVATIONS ON MIGRANT BUTTERFLIES IN FLORIDA, U.S.A., MADE BY MR. AND MRS. K. HODGES DURING 1937, 1938 AND 1939.

By C. B. WILLIAMS.

In May 1937 a letter was received from Mr. and Mrs. Karl Hodges of Indiatlantic-by-the-Sea, Melbourne, Florida, with a full account of a migration of *Ascia monuste* and an offer of help for further observations, which was gratefully accepted.

Specimens of many species were sent to Rothamsted for identification, and named ones were returned to the observers so that they rapidly got to know the more conspicuous species.

During the remainder of 1937 Mr. and Mrs. Hodges sent in other general observations on movements, and at the beginning of March 1938 they started an almost daily watch which was continued until November 1939. Each day a smaller or larger number of butterflies was caught and placed in an envelope, on the outside of which were written notes on the temperature, wind, weather, the species observed and the direction of their flight. These have been sorted out and tabulated, and form a unique series of observations giving information on several new migrants as well as on butterflies whose migration was already established.

Altogether nearly 2200 specimens have been sent in, so that there has been a very frequent check on all the identifications. Fortunately the principal migrants of this area are easy to distinguish from related species, but some difficulty has been experienced in separating the "Skippers" (HESPERIDAE) and the observations on these are not given in full here.

The locality where almost all the observations have been made is Indiatlantic-by-the-Sea, which is on the Atlantic coast of Florida, on the long narrow island which is separated from the mainland by the so-called "Indian River," really a lagoon. The nearest town is Melbourne, a few miles due west, which is itself about 60 miles S.E. of Orlando. The island is at this point about 2 miles wide and the Indian River about the same width. Most of the observations were made within a quarter of a mile of the shore but a few were made on the banks of the Indian River or from the bridge which crosses it.

Owing to the immediate vicinity of the Atlantic Ocean to the east almost all records of flight are either to the north or to the south. No butterflies could be flying from east to west as they would have to come out of the ocean, and the butterflies observed showed no tendency to fly out to sea to the east.

I would like to take this opportunity of thanking Mr. and Mrs. Hodges for the great enthusiasm and intelligence they have shown in making the observations.

In fig. 9 are shown diagrammatically the days on which observations were taken and the direction of the wind whenever mentioned. Between the 7th

March 1938 and the 31st October 1939, observations on insects were made on 576 days. On 45 of them the wind was not noted, on 100 of the remainder it was stated to be " calm," or " no wind." During the 431 windy days the wind was from the S.E. on 173 days or about 40% ; the next most frequent directions being N.E. and E. These three directions, all from the easterly quarter, account for 75% of all the days with wind. On the other hand, on only 57 days (13%) were the winds from the W., N.W. and S.W.

An examination of the records for each month shows that the prevalence of S.E. winds is most marked from February to September inclusive. From October to January the most prevalent wind is from the N.E., with E. and S.E. next in occurrence.

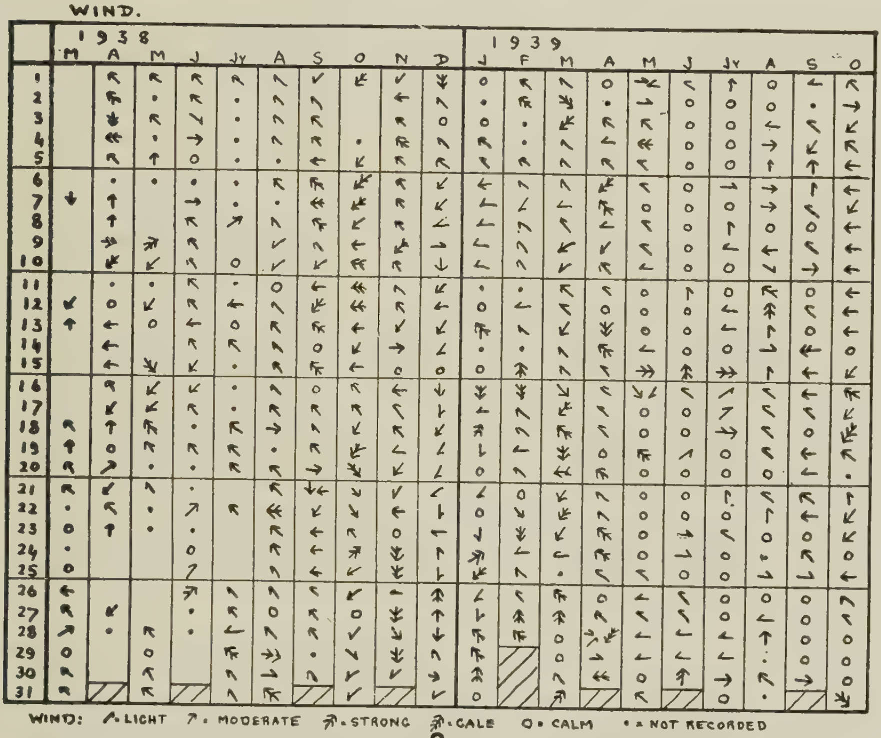

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FIG. 9.—Direction of wind during the period of observations of migrant butterflies made by Mr. and Mrs. Hodges in Florida.

Ascia monuste L. (The Great Southern White).

In a recent paper (Williams 1938b) the information available on the migrations of this butterfly in the U.S.A. was summarised. There was a number of records almost all along the Atlantic coast of Florida and nearly all in the months of April to June. About 24 records from localities south of New Smyrna (lat. 29·3° N.) were all in a southerly direction, while about a dozen records north of New Smyrna were more frequently to the north than to the south but included both directions. The information appeared to support a theory that there was some point of origin of the swarms about the latitude of New Smyrna from which migrations went both to the north and to the south.

Mr. and Mrs. Hodges' records during 1937 were included in this summary. In this year they observed a movement towards the south at Indiatlantic Beach from the end of May to the end of July; but they noted that on the 5th and 6th of July only the flight changed direction and went towards the *north*. Not one butterfly was seen from the end of July until the early spring of 1938.

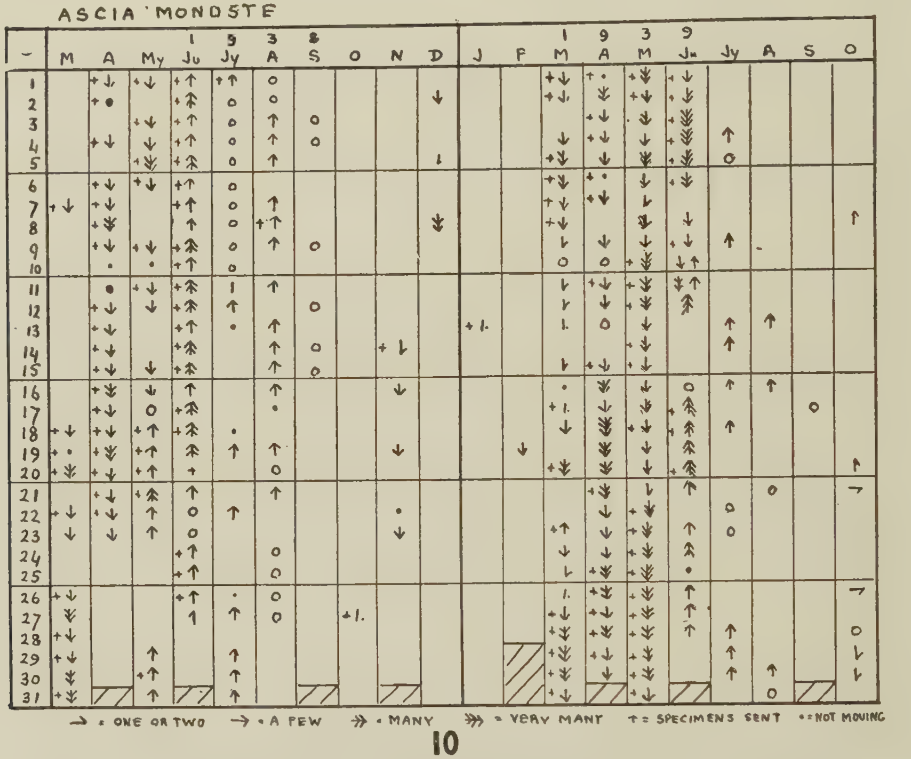

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Fig. 10.—Observations by Mr. and Mrs. Hodges in Florida on the movements of *Ascia monuste*.

In 1938 the first one caught was on the 7th March and the observations from then on are tabulated in fig. 10. The results in the first half of 1938 are very striking and unexpected. *A. monuste* flew southward in very large numbers almost every fine day from the end of March to the 16th May. Then, after no butterflies seen on the 17th, the flight resumed on the 18th in the exactly opposite direction, towards the north, and continued in this direction quite markedly during the whole of June, with occasional individuals during July and the first half of August, all to the north.

From the 21st August no butterflies were seen until a single one on the 27th October and a few scattered individuals, mostly apparently moving to the south, in November and December.

The species did not become abundant again until the beginning of March 1939, when the southward flight set in and continued without a break until the 9th June, with specially heavy flights about the 18th April, the 10th and 25th May and the 3rd–5th June. On the 10th and 11th June individuals were seen going both to the north and to the south. On the 12th June a very definite flight set in towards the north, which lasted throughout June in considerable numbers and was noticed in small numbers on several days in July and occasionally throughout August. None was noticed in September and only one or two individuals in October flying in various directions.

Table 15.

Numbers of white, intermediate, and grey individuals of *A. monuste* captured at different times of the year in Florida. The row of crosses xxx indicates the time of reversal of flight direction.

		1937			1938			1939			All 3 years			% grey.
		Wh.	In.	Gr.	Wh.	In.	Gr.	Wh.	In.	Gr.	Wh.	In.	Gr.	
March	1–10				1	0	0	10	0	0	11	0	0	0
	11–20				11	0	0	2	0	0	13	0	0	0
	21–31				11	1	0	31	3	0	42	4	0	0
April	1–10				30	10	0	6	0	0	36	10	0	0
	11–20				26	24	3	1	2	0	27	26	3	5
	21–30				5	4	3	120	1	15	125	5	18	12
May	1–10				8	1	4	4	0	3	12	1	7	36
	11–20				1	0	7	58	0	44	59	0	51	45
						x x x x x								
	21–31	11	0	16	1	0	4	17	0	26	29	0	46	60
June	1–10	20	2	13	14	0	8	37	0	27	71	2	48	40
									x x x x x					
	11–20				30	1	16	48	0	3	78	1	19	19
	21–30				6	0	2	—	—	—	6	0	2	(25)
July	1–10				1	0	0	—	—	—	1	0	0	—
	11–20				1	0	0	—	—	—	1	0	0	—
	21–31				—	—	—	—	—	—	—	—	—	—
Total for year		31	2	29	146	41	47	334	6	118	511	49	194	
Total, all varieties			62			234			458			754		

Thus in 1937 there was evidence of a change of direction from the southerly to the northerly flight for two days at the beginning of July; in 1938 the direction changed definitely and permanently after the 18th May; and in 1939 the same change happened on and after the 9th and 10th June.

The species *A. monuste* is always white in the male sex, but the female can be either white or grey (form *phileta* Fabr.) or more rarely intermediate in colour.

In the course of the three years Mr. and Mrs. Forbes sent over seven hundred and fifty specimens for examination and the proportion of the whites, intermediates and greys is shown in Table 15. Unfortunately it is very difficult and sometimes impossible to distinguish between the white males and the white females in the dried and somewhat rubbed material available for study.

It will be seen that neither grey nor intermediate forms are present at the beginning of March, all specimens sent being white. In the last week in March a few intermediates begin to appear and by the second week in April full grey females are found in small numbers. The percentage of these to the total population rises rapidly to a maximum of about 60% in the last week in May and then falls again during June. The exact extent of the fall is uncertain as only a few specimens were captured after the second week in June.

In 1938 the specimens captured in the second half of May, just after the change of direction from south to north, were 2 whites and 11 greys—a considerably higher proportion of greys than had been present in the weeks before the change of direction.

In 1939, on the contrary, the specimens caught in the second ten days of June just after the change of direction were 48 whites and only 3 greys, a very sudden drop in the proportion of greys. The evidence is contradictory but does not seem to support the idea that the same individuals that have gone south turn round and come north again.

After the end of July very few specimens were captured. They included one grey in August 1939 and one white in October and November 1938 and in January and October 1939.

There is a small amount of evidence that the whites and the greys keep apart in the flights; thus Mr. and Mrs. Hodges write on 3rd May 1939: "The grey females have been fewer this year and it was not until the 28th April that they appeared in any numbers. We netted many in the morning flying south with the whites but in their own column. They were flying in about equal numbers with the whites." Again they say, speaking of the same date: "Whites and greys flying about 60 per minute. Nearly all the greys in this envelope were netted in single column without whites."

Mr. and Mrs. Hodges made also many general observations on the flights, of which the following might be quoted to give some idea of the migration at its height:—

"On Wednesday, 26th April 1939, the whites were flying south all day in single column from the Indian River to within about 100 yards of the Atlantic Ocean beach, which we call the 'Beach Lane'. Here the butterflies spread out in a blanket of white several yards wide, flying fast. Over a hundred per minute passed just like a cloud in the morning, while in the afternoon they increased to at least 300 per minute for a width of over 300 feet. Close to the rim of the ocean was another column with Ocean Drive separating it from the last described.

"At intervals within the space of a mile all those on the east side of the drive had crossed until only a single column was left to pass through Melbourne Beach Town, all others joining and flying on towards Sebastian Inlet some twenty miles south.

"In this flight only a few greys could be seen. All were flying from 2–5 feet from the ground at a speed of about 25 miles per hour. They would fly into the net as you held it in front of them and were so close that five or six or more were netted at one sweep."

The observations just summarised do not support the suggestion made in the first paragraph (p. 143) that the flights originated in the New Smyrna district and from there spread both north and south. Although these new observations relate to only one locality, they extend very considerably to the south the area where northerly flights occur, and show that a definite change of direction can occur in a single locality.

Danaus plexippus.

In 1937 two specimens were captured on 31st May, but at the end of September Mr. and Mrs. Hodges reported that altogether they had seen only these two. Individuals were again seen, flying to the south, on 13th and 30th October and on 5th and 9th November 1937. On the latter day they reported Monarchs flying to the south 3–20 feet above the ground.

No others were noted till the 5th April 1938 and the observations from this date are summarised in fig. 11. From the 20th April to the 12th May a few were seen going north but from that date till 4th October not a single one was observed. On this date, however, they reappeared in numbers and there was some evidence of a southward drift during October. They remained in the neighbourhood in moderate numbers throughout the winter and were again seen going north in small numbers during March and April 1939, and the last individual was seen on the 8th May also going north. They reappeared in the autumn on the 17th October and were seen in small numbers during the rest of October, most moving to the south.

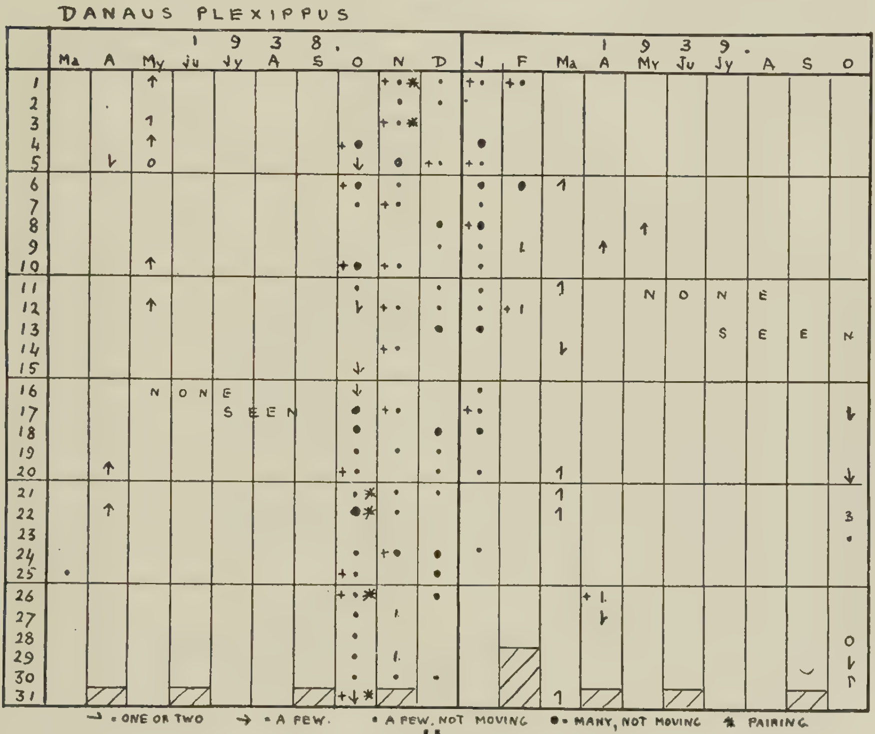

FIG. 11.—Observations by Mr. and Mrs. Hodges in Florida on the movements of *D. plexippus.*

The dates of first appearances in the autumn were thus 13th October in 1937, 5th October in 1938, and 17th October in 1939; and the last appearances in the spring were 31st May in 1937, 12th May in 1938 and 8th May in 1939.

Pairing was noticed at the end of October and the beginning of November 938.

The evidence is entirely consistent with the theory of an autumn migration into Florida from the north and a return flight to the north in the spring.

About 42 specimens were captured which were all of the typical North American type with the spots just beyond the cell in the fore-wing pale buff, and distinct red-brown markings in the dark apex of the wing (see p. 156). There is no evidence from this material of the presence in Florida of the Central American type which is believed to be non-migratory. There seems also to be little evidence of a resident population remaining in the Melbourne District of Florida during the summer.

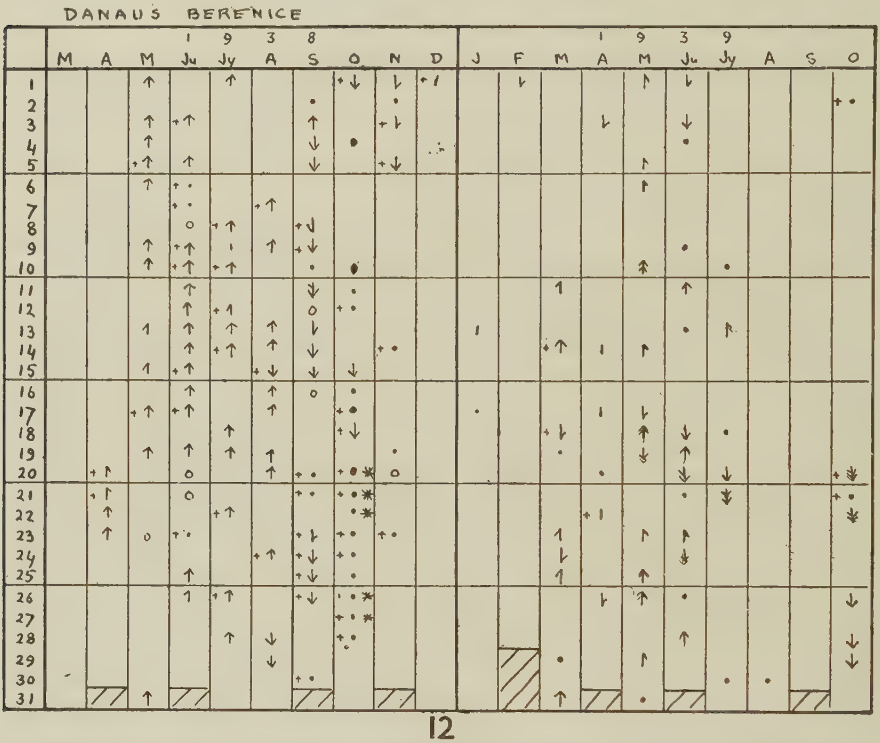

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FIG. 12.—Observations by Mr. and Mrs. Hodges in Florida on the movements of *D. berenice.*

Danaus berenice.

Previous to the observations of Mr. and Mrs. Hodges the only indication that *D. berenice* could migrate was in an old record by Maynard (1886, *The Butterflies of New England*, Boston : 8), who wrote : " I saw hundreds of *D. berenice* flying to the east over the Atlantic 50 miles from land." No date or locality was given.

Mr. and Mrs. Hodges' records in 1937 showed that the species was present in large numbers about the 14th July flying over flowers and easy to net. Most had gone by 2nd August but it appeared in smaller numbers at least up to 16th September.

Regular observations were started in 1938 and the results are shown in fig. 12. It will be seen that in 1938 there is a very definite movement to the north throughout April, May, June and July. During August, flights in both directions were noted, and from the beginning of September an equally definite southerly movement set in which was noticeable until early November. Pairing was noticed at the end of October. Only an occasional individual was noticed from the 5th November till the middle of March 1939. Then they became more common during March and April but with little indication of a northerly movement up to the beginning of May. During May, however, small numbers were recorded as flying to the north, particularly on the 10th. During June and July small numbers were seen sometimes flying to the north and at other times to the south. Only three individuals were seen between the 22nd July and the 19th October but on the 20th October there was a steady movement to the south which continued with some breaks to the end of the month.

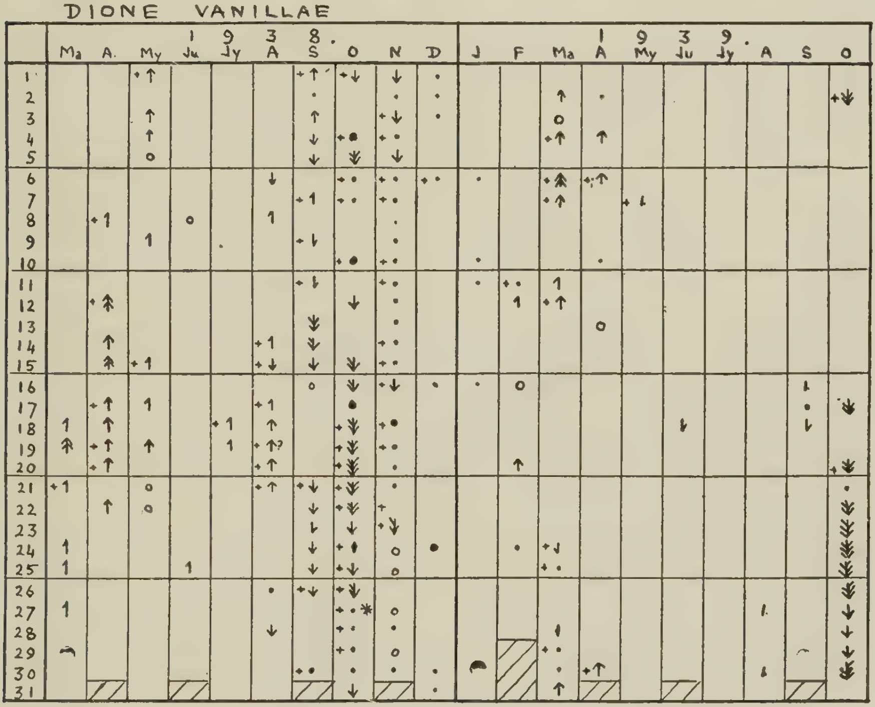

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Fig. 13.—Observations by Mr. and Mrs. Hodges in Florida on the movements of *Dione vanillae*.

Nearly 100 specimens were sent in at intervals to check the identification and all were *D. berenice*.

The observations lend quite definite support to the idea of a northerly movement in the spring and a southerly movement in the autumn in Florida.

Dione vanillae.

The first specimen captured by Mr. and Mrs. Hodges was on 28th August 1937, and they report that from that day to the 23rd September many appeared each day flying to the south.

Four specimens were captured on the 8th September and single ones on the 14th and 15th October and the 3rd November—all these were moving to the south.

There is no other record until the 18th March, when a single one was seen going to the north, followed on the next day by a record of "many going to the North." The records from this date are shown in fig. 13.

It will be seen that there was in 1938 a regular movement to the north during March, April and May; single specimens only were seen in June and July, becoming a little commoner again in August; and finally a very definite southerly movement in September and October, becoming much less distinct in November.

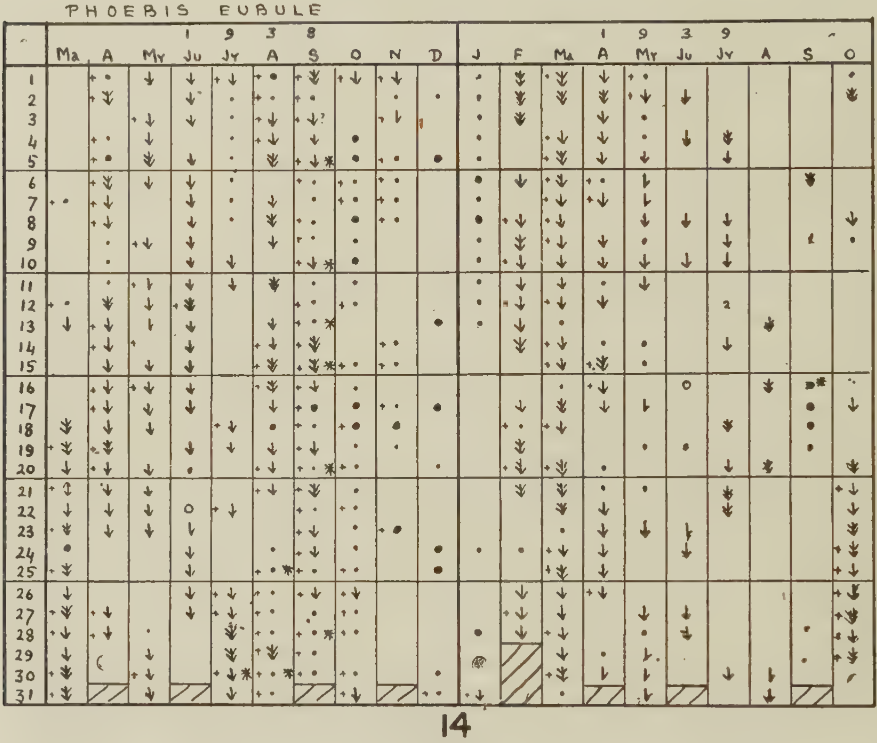
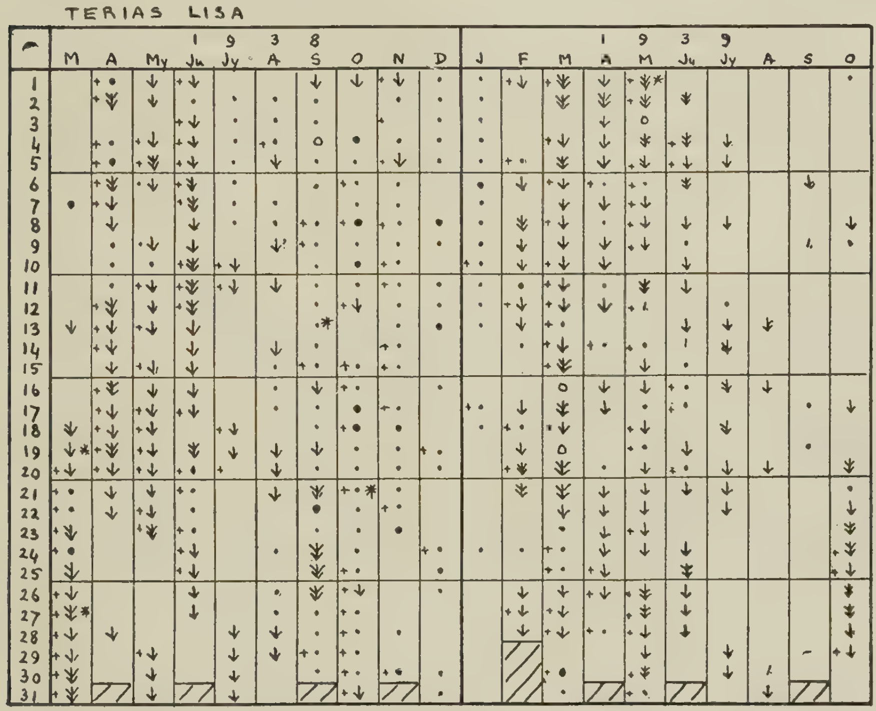


Fig. 14.—Observations by Mr. and Mrs. Hodges in Florida on the movements of *Phoebis eubule*.

No butterflies were then seen from the 23rd November 1938 till the 12th February 1939, when one was going to the north. During March and April 1939 there was again a definite movement to the north, but this did not appear to be as large as in 1938. Only two individuals were noted between the beginning of May and the 27th August (one in May and one in June); two were seen in the last week in August, a few in mid-September, a number flying south at the beginning of October and then about the middle of October a large southerly flight developed, which, on the 24th October, reached an intensity of 120 butterflies per minute within sight.

Previous to these observations, *D. vanillae* had been recorded taking part in directional flights in the Galapagos Islands and in the Argentine, but there was only a single record for N. America when Johnson (1899, *Ent. News* **10** : 21) referred to a flight in Florida in September towards the south, but gave no year or further details.

There appears to be no doubt that this species has in Florida a regular movement towards the north in spring and a very definite movement in large numbers towards the south in autumn.



15

Fig. 15.—Observations by Mr. and Mrs. Hodges in Florida on the movements of *Terias lisa.*

Phoebis eubule.

This is a well-known migrant and records of directional flights are known in the United States, in Tropical America and as far south as the Argentine. Previous information (Williams 1938b) indicated that in the U.S.A. there is a very definite southerly or south-easterly movement in the autumn and a much smaller one towards the north or north-west in the spring (see p. 188). In the Argentine northerly movements have been recorded in the autumn but there is so far no record of a spring movement away from the Equator (Williams 1930b).

With this information in hand, the observations made by Mr. and Mrs. Hodges are very puzzling, as they observed almost continuous flights towards the south throughout most of the year.

In 1937, they reported *eubule* going south along with a big flight of *P. monuste* at the end of May. In mid-August they wrote : " Nearly every day we note large yellows flying about with general direction south." On 23rd September: "Still the movement to the south continues," and later that during December 1937 and January and February 1938 the movement south continued whenever there was not a cold wind or heavy cloud. The observations from March 1938 are tabulated in fig. 14 and show movement to the south in all months except perhaps October to January.

Pairing was noted once during July, once in June, during August, on several occasions during September 1938, and once during September 1939.

The butterfly was present in fair numbers during every month of the year. Up to April 1933 they had sent 313 specimens, of which 140 were males and 173 females. Both sexes were present in every month when more than one individual was caught and in general they were in more or less even proportion. The following larger departures from equality are noted but they do not appear to be of any significance :—August 1938, 7 males to 28 females; October 1938, 22 males to 11 females and March 1939, 4 males to 19 females.

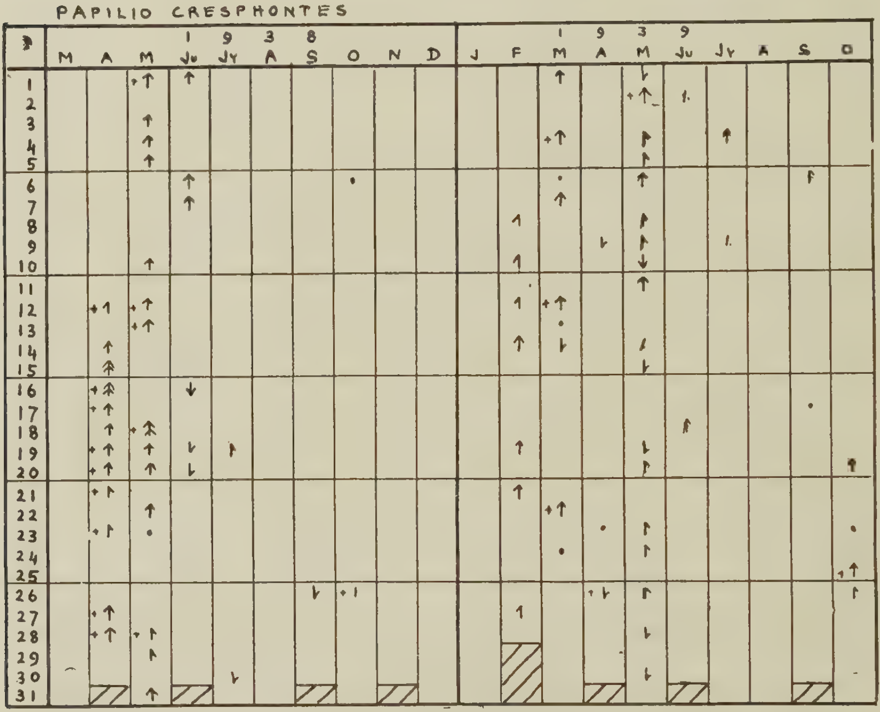


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Fig. 16.—Observations by Mr. and Mrs. Hodges in Florida on the movements of *Papilio cresphontes*.

Terias lisa.

Previous to the observations of Mr. and Mrs. Hodges, the only evidence of migration in this species was the fact that on several occasions large numbers had appeared suddenly in the Bermuda Islands.

In 1937 Mr. and Mrs. Hodges reported that on the 24th May *T. lisa* was joining in a southward movement of *A. monuste.* Three specimens were sent. From that time till 20th September they were generally common and showed a definite tendency to move to the south. In December 1937, January and February 1938, it was again " moving southwards whenever the weather was not wet or cloudy."

The more regular observations after March 1938 are shown in fig. 15 and indicate a continuous movement towards the south which is at its maximum in April, May and June but occurs in all months except November, December and January.

The observations on *Terias lisa* thus closely resemble those on *Catopsilia eubule*, which also appears to move only to the south in this locality. No explanation can yet be put forward and more observations are required especially in Florida away from the coast line.

The identification was checked from nearly 300 specimens sent at intervals during the two years.

Papilio cresphontes.

I have been able to trace only one record of directional movement in the " Giant Swallow tail," previous to the observations of Mr. and Mrs. Hodges. Saverner (1908) recorded it flying south on Lake Erie, Canada, in August and September 1907 with *Papilio troilus* and *Danaus plexippus.*

Mr. and Mrs. Hodges noted it moving in small numbers on many occasions which are tabulated in fig. 16. The records indicate a definite movement to the north in the spring of both 1938 and 1939.

Only very rarely, however, was the butterfly seen in the autumn and there is at present no evidence in support of a return flight at this time of the year.

About 20 specimens were captured at intervals and sent in for confirmation of the identifications.

Eudamus proteus.

According to Scudder (1889 : 1333) this Hesperid butterfly, known as the " Long-tailed Skipper," is a typical southern species which occasionally appears in some numbers in the south-western corner of New England.

Mr. and Mrs. Hodges first recorded it in September 1937 as migrating south from the 12th to 20th of that month, 2 to 3 feet above the ground, during clear warm weather with winds chiefly from the S.E.

No other observation was made till September of 1938, from which date the records are tabulated in fig. 17. It will be seen that there was again a definite movement to the south between the 16th September and the 5th November. Pairing was observed on the 21st, 22nd and 23rd October.

The insect remained in this neighbourhood throughout the winter without any direction movement, but in February and March movement was again noted; not in any fixed direction, sometimes to the north and sometimes to the south.

There were a few records of southward flight in July and August of 1939 but no extensive movement till the end of October when the southward flight set in in large numbers.

Thus a definite southward flight has occurred in the autumn of all the three years during which observations have been made.

Vanessa virginiensis Drury (= *huntera* F.).

The first specimen of this species, known as " Hunter's Painted Lady," sent by Mr. and Mrs. Hodges was captured on 2nd April, 1938.

No other observation was made until 30th September, when another specimen was sent with the remark : " Many are going south."

On 27th February 1939 one was " netted on flowers about noon."

The next observations were made from 23rd to 25th March 1939. Mr. and Mrs. Hodges write that on the 23rd March " we discovered two other movements to the north, one a brown butterfly. . . . On the next day we saw many and netted one by the Indian River."

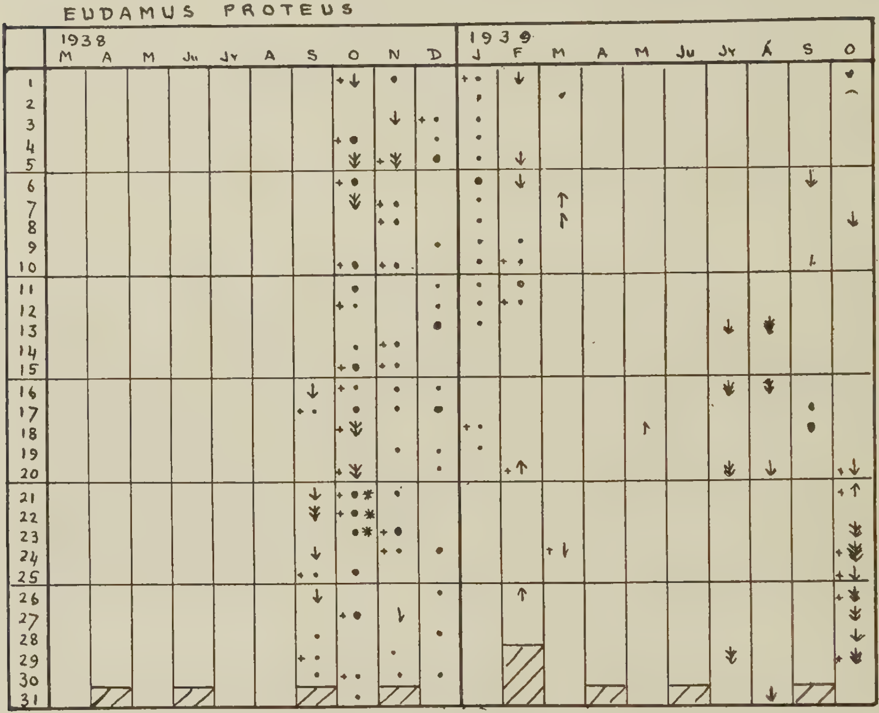

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FIG. 17.—Observations by Mr. and Mrs. Hodges in Florida on the movements of *Eudamus proteus*.

Additional notes were that on the 23rd March the butterflies were flying " above the whites (*A. monuste*) about 15 feet from the ground and very fast—30 m.p.h. to the north."

On the 24th they were " going all day in single column 20 m.p.h."

On the 25th " Several seen going north fast in single column."

Finally on 31st March another was captured on the east bank of the Indian River and sent with the note " About one every minute going north with Whites (*A. monuste*), occasional Queens (*D. berenice*), and Gulf Fritillaries (*D. vanillae*)."

To sum up, no specimens were seen except in the spring and autumn and there is distinct evidence of a northward flight in the spring and a southward flight in the autumn.

It is remarkable that not a single specimen of *Vanessa cardui* was sent by Mr. and Mrs. Hodges, but on the other hand neither in 1937 nor in 1938 was the Painted Lady present in large numbers in the U.S.A. generally.

The problem as to whether this latter species enters the U.S.A. through the West Indies and Florida is of considerable interest (see Williams 1938b). At present the only evidence of migration of *V. cardui* in Florida is that early in May 1916 near Key West, Mr. Honoré, a visitor from Europe, found himself surrounded by butterflies which he identified as *V. cardui* because they were similar to the European species with which he was familiar. No specimens were captured and, in view of Mr. and Mrs. Hodges' observations on the occurrence and movements of *Vanessa virginiensis*, it must be recognised that Mr. Honoré may have mistaken this latter for *V. cardui.* Further observations on the occurrence of both species in Florida are greatly needed.

I have been able to find only one other record of migration of *V. virginiensis* in U.S.A. and that is by Shannon (*Amer. Mus. J.* **17** : 33–40), who states that at Long Beach, Long Island, N.Y., in August and September 1919 numbers were flying steadily to the west in company with many *D. plexippus* and various dragonflies.

It is interesting to note that the butterfly has been recorded on five occasions in the British Isles : once in Ireland, once in South Wales, twice on the south coast of England, and one specimen in the Dale collection without exact locality but stated to be British.

Vanessa atalanta.

On 30th March 1939 Mr. and Mrs. Hodges report " we noticed a butterfly flying fast to north; also on 31st March we watched them but they were too high up to net, until two flew lower than the others. One settled on the blossom of an Oleander bush and was captured. Estimated numbers flying one every half hour to the north for two days."

The specimen was the Red Admiral, *Vanessa atalanta*, and this was the only occasion on which this species was sent to me. It is a well-known migrant in Europe but there is only one previous record (Davis 1912) of a directional movement in North America.

VI. SUMMARISED OBSERVATIONS ON SPECIAL SPECIES.

By C. B. WILLIAMS.

(1) *Danaus plexippus.*

Variation and geographical distribution.

The Monarch butterfly extends, in one or other of its forms, from Alaska and Hudson Bay in North America to Patagonia in the south. There are, however, colour and pattern differences which enable individuals coming from certain areas to be distinguished from those coming from elsewhere.

The main differences are found in the fore-wing; first in the presence or absence of the dark bar along the hind margin of the wing; secondly in the colour of the four or five larger spots near the tip of the wing, which vary in colour from white to buff; and thirdly in the extent of the development of red-brown areas in the dark scaling near the tip of the wing. These are in addition to slight sexual differences (Plate 1).

Owing to the work of A. H. Clark (1931 and 1932) at Washington, Forbes (1939) at Cornell and Talbot at the British Museum, one can now recognise three moderately distinct forms with fairly definite geographical distributions and one series of intermediate forms found chiefly in the area where two of these forms overlap.[1]

The race in South America south of the Amazon is perhaps the most definite and has been considered as a distinct species by many writers. It is characterised by the absence of the dark bar along the hind margin of the front wing (Plate 1, C). This bar is present in all the other forms.

At the other end of the range in North America there is a race in which the spots in the fore-wing are very distinctly buff in colour and the red-brown areas beyond the spots are distinct and well developed (Plate 1, A).

In the northern portion of South America there is a Tropical American form in which the bar at the hind margin of the fore-wings is present, the spots across the apex of the fore-wing are white, and the red-brown areas near the tip are absent, this area being uniformly almost black-brown (Plate 1, B).

I have not yet seen any specimens intermediate between the forms in the south and the north of South America but in the West Indies, in Panama and occasionally on the north coast of South America individuals occur which are definitely intermediate between the North American and the Tropical American races. These may have the spots white but with distinct traces of the red-brown areas; or may have the spots or some of them buff in colour but with the red-brown areas absent.

It is not the purpose of the present paper to enter into controversies of nomenclature but for reference that adopted by each of the authorities already mentioned is given below. For purposes of description I will use the nomenclature of Clark.

Race	Clark	Forbes	Talbot
1. N. American . .	*plexippus*	*menippe*	*plexippus*
2. Intermediate . .	—	—	*megalippe*
3. Tropical American .	*nigrippus*	*megalippe*	*nigrippus*
4. South American . .	*erippus*	*erippus*	*erippus*
Whole range . .	*Danaus plexippus*	*Danaus erippus*	*Danaus plexippus*

I have examined over 1000 specimens of this butterfly in my own possession and in the collections at the British Museum, Tring, Oxford and Munich and the distributions of the different races as shown by these specimens are shown in the map (fig. 18 A–D).

It will be seen that *erippus* ranges from Brazil south of the Amazon southwards to North Patagonia, and westward to the Andes in Bolivia and in the Argentine. I have so far seen only two specimens which might have come from the southern part of the Pacific coast area west of the Andes. These were both labelled "*Chile*". One is in the collection of the British Museum and is typical *erippus*; the other is in the Tring collection and is typical North American *plexippus*. In neither case is the exact locality given or the collector's name, and both specimens are subject to considerable doubt. The insect is said to be not uncommon in Chile by Figueroa (1929) but his figure is copied from a North American journal and does not necessarily represent the form found in Chile.

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[1] As this paper was in the press an important paper on the variation and geographical distribution of *D. plexippus* by Dr. A. H. Clark has appeared in 1941, *Proc. U.S. nat. Mus.* **90.** It should be consulted by all who are interested in this problem.

Since the above was written I have received from the Department of Agriculture of Chile, one specimen captured by Mr. F. Ruiz at Las Mercedes, Talca, Chile, in 1925. It is a typical South American *erippus*. Talca is south of Santiago in latitude 35°.20′ S.

It is interesting to note that many of the *erippus* caught in the Para district of Brazil, near the northern limit of its range, have the spots in the outer portion of the fore-wing white instead of buff, but in none that I have seen do the red-brown areas outside these tend to disappear. Thus both the southern and the northern forms seem to undergo somewhat similar variation as they approach the Equator.

The Tropical American form, so-called *nigrippus*, is found, according to our map, in Brazil north of the Amazon, in the Guianas, Venezuela and Colombia, and in the west it ranges through Ecuador to Peru, much farther south than the northern limit of *erippus* in the east. It is also found occasionally in some of the West Indian Islands and according to Clark one has been captured in Florida (18th Dec. 1936), one in N. Carolina (4th July 1938), four in Louisiana (Nov. 1937) and two in West Virginia (15th June and 4th July 1938) (A. H. and L. F. Clark 1938b). These specimens I have not seen and it is possible that they might be classified as intermediates rather than the true *nigrippus*.

There is one typical *nigrippus* in the British Museum from the Galapagos.

The intermediate form, which is so variable that I doubt the justification of the use of the varietal name *megalippe*, is found occasionally in the north of South America and more frequently in the southern portion of Central America and some of the West Indian Islands and occasionally as far north as Mexico.

The northern form *plexippus* is almost completely dominant in the whole of North America, Mexico, Central America to about the level of Nicaragua, and the Bahamas Islands. It is also found in Cuba, Jamaica, Haiti and some of the Virgin Islands along with intermediates. One specimen which appears to be almost typical *plexippus* is in the Tring collection labelled Bogota, Colombia.

It is this North American form which appears to have spread over most of the world and all the specimens I have seen from the Pacific Islands, from Australia and New Zealand, from the Azores and Canary Islands in the East, and all but one of the British-caught specimens (see p. 183), are of this type.

It should be noted that in the area populated by the intermediate and *nigrippus* type the females seem to vary more rapidly towards *nigrippus* than the males, and in Nicaragua and Costa Rica the females are intermediate while the males are still of the northern type. A variation also occurs in which the wings are very heavily veined and these are nearly all females. In Colombia this appears to be the typical form of the female of *nigrippus*.

To sum up: there are three forms, a South American, a Tropical American and a North American, with intermediates between the two last. The South American form is known to undertake large migrations and so is the North American, but there is at present no definite evidence of migrations of the tropical form or of the intermediates. The limits of the distribution of these should therefore help to fix the limits of the movements of the two other forms towards the Equator. Thus it would appear that the normal southern limit of the movements of *plexippus* must be somewhere in Mexico, Cuba and the Bahamas; while the northern limit of *erippus* is, in the East at least, the Amazon.

So far I have been unable to examine specimens from the large forest area of Central Brazil, and Mr. W. J. Kaye, who has had considerable experience in Tropical America, writes that he considers that the Monarch is never common under such very humid conditions.

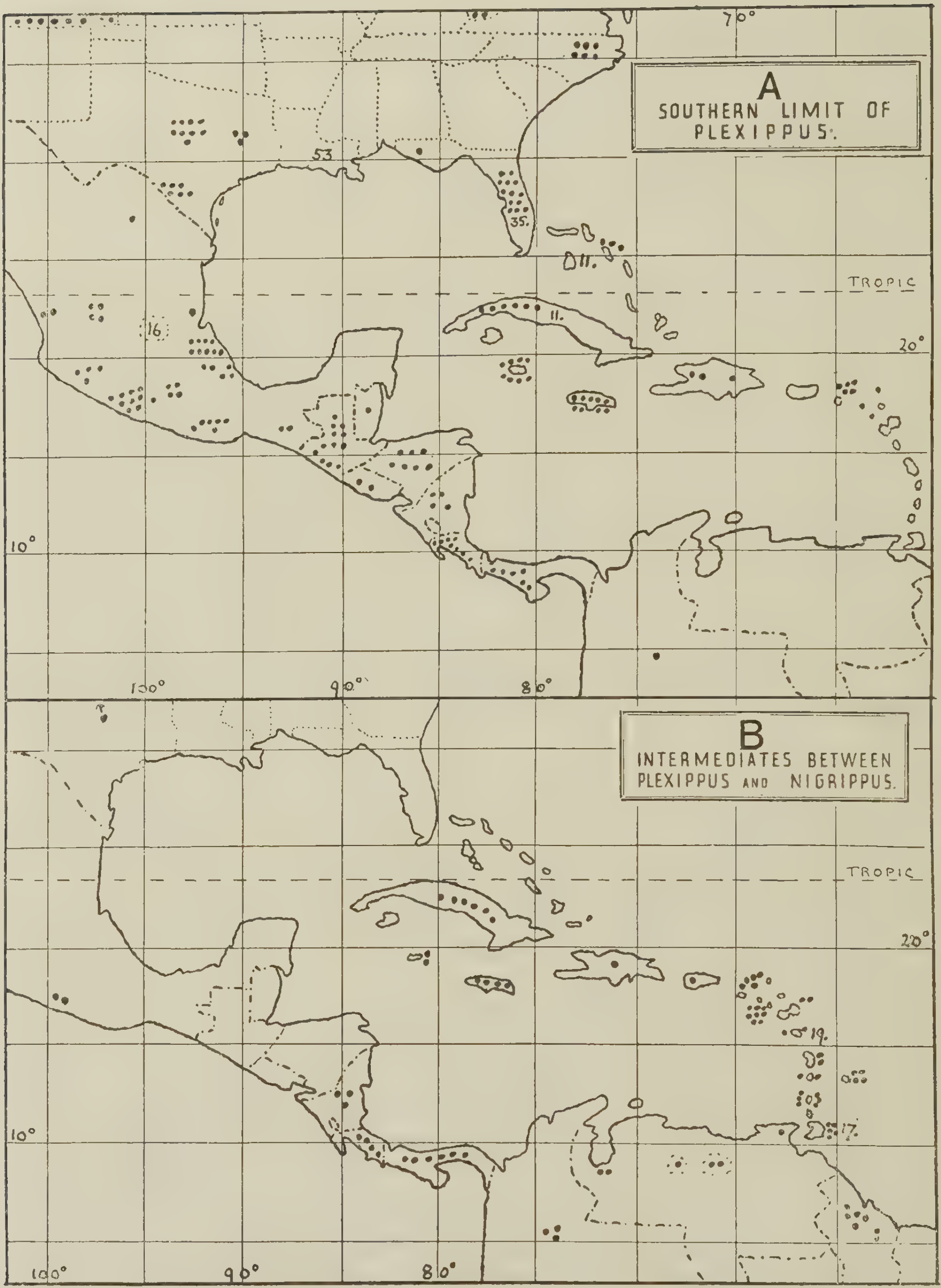
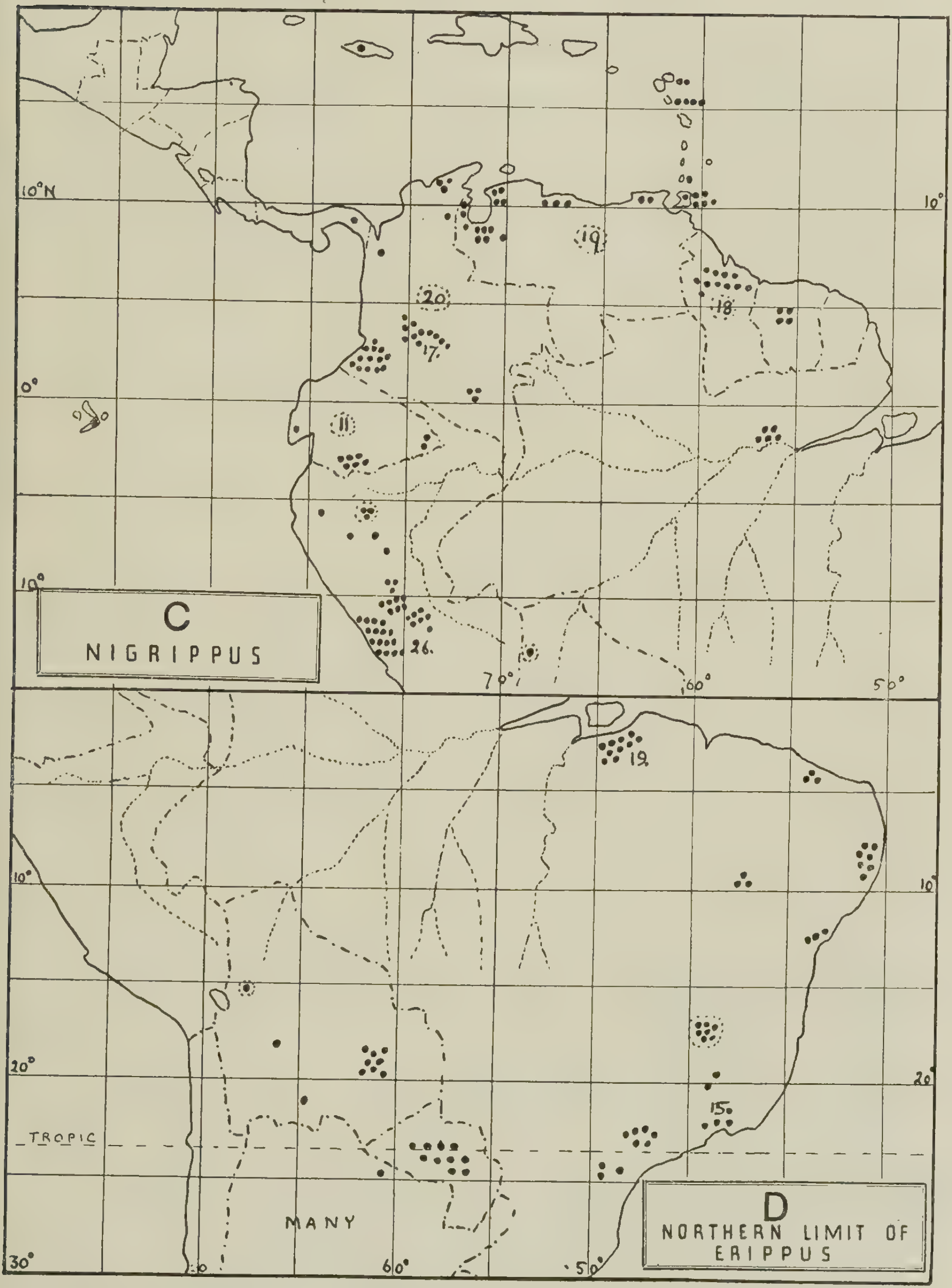

70°
A
SOUTHERN LIMIT OF PLEXIPPUS.
53
35.
11.
11.
TROPIC
20°
16
10°
100°
90°
80°
B
INTERMEDIATES BETWEEN PLEXIPPUS AND NIGRIPPUS.
TROPIC
20°
19.
17.
10°
100°
90°
80°

Fig. 18.—Map showing the distribution of the different geographical races of


10°N
10°
0°
11
20
17
19
18
10°
C
NIGRIPPUS
26.
70°
60°
50°
12
10°
10°
20°
20°
15.
TROPIC
MANY
30°
60°
50°
D
NORTHERN LIMIT OF
ERIPPUS

Danaus plexippus in North, Central and South America.

The migrations and reproductive cycle of the Monarch butterfly in California.

By J. A. Downes.

In the Pacific Coast States *Danaus plexippus* L. performs migrations similar to those occurring in the East and Middle West, but the precise point of origin of the autumn migration, and the course of both the autumn and spring flights, seems to be largely unknown. However, several of the overwintering places, the termini of the autumn migration, are well known to West Coast entomologists, and are to a lesser extent recorded in the literature. The following notes deal with these overwintering places and with the behaviour and reproductive condition of the butterflies during the migrations and winter, for the seasons 1937–38 and 1938–39.

The overwintering sites. Williams (1938b) records the following localities as winter resting-places for the western population: Stinson Beach, Marin Co.; Pacific Grove, Monterey Co.; between Pismo and Oceano, San Luis Obispo Co., and probably southwards to San Diego; Santa Monica, Los Angeles Co., Laguna Beach, Orange Co., and southwards: all in California. For all these localities it was known that the same place and sometimes even the same group of trees had been used by a group of the butterflies in several or even many winters. I have myself observed these overwintering groups at Stinson Beach; El Cerrito, Contra Costa Co.; Pacific Grove; at seven localities on the coast from about 20 to 40 miles south of Pacific Grove; Pismo; Santa Barbara; Ventura; and three places in the immediate neighbourhood of San Diego. There are also reports, which I was not able to check personally, from the Berkeley campus of the University of California; the shore of Napa Creek; Tomales Bay, Marin Co.; and at a site 15 miles inland in Contra Costa Co. Thus all the known localities are in California, rather widely spread out along the coast of about 600 miles, extending from Stinson Beach (or possibly Tomales Bay) in the north to San Diego in the south; but there are undoubtedly others farther south along the coast of Baja California. Moreover, all localities are very close to the coast, or the shores of San Francisco Bay; nearly always within half a mile of the water, but as much as fifteen miles away at the possible inland Contra Costa Co. record.

In all cases the actual place chosen is a fairly large and dense group of trees, usually but not always in an exposed position such as on top of a cliff. The tree chosen varies, and is probably not an important factor; at Pacific Grove it is Monterey Pine, at El Cerrito Monterey Cypress and Eucalyptus, and at most other places Eucalyptus alone. They are all evergreens, as are practically all the trees in the coastal regions. The butterflies settle on the leaves and twigs, fairly high up (always above 20 ft.), and, at least when the group is large, are exceedingly gregarious (Plate 2). Thus at Pacific Grove in the winter of 1938–39, of a group of the order of 10,000 individuals, at least nine-tenths were clustered on only five small branches where they hung in great masses almost obscuring the leaves. This spectacular massing has been observed at Pacific Grove, Pismo, Santa Barbara, Ventura, Santa Monica region, and San Diego, but in most places the groups are smaller (a hundred or so, and more usually only about a dozen) and the clustering, if it occurs, has not been noticed. In most places where large groups have been observed, and also at Stinson Beach and El Cerrito, it is a matter of common knowledge that the butterflies return every winter to the same group of trees, and sometimes even to the same branches; at Pacific Grove there are some permanent sign-posts to " The Butterfly Trees," which are one of the sights of the town. The problem therefore presented itself to some entomologists: "How are the autumn butterflies, which are separated by from one to several generations from the group resident in the preceding winter, able to find their way year after year to these few small places from points perhaps many hundreds of miles away?" In reality, however, the situation is much simpler, as the following observations show. For twenty miles along the coast a little south of Pacific Grove (Nov. 1938) and for ten miles in the neighbourhood of San Diego (Jan. 1939) every suitable group of trees was examined; only fourteen possible sites were found, at ten of which at least a few Monarch butterflies were seen. There is no doubt that this is typical of the situation along the whole coast from San Francisco to below the Mexican line. The fact that they occur at almost every suitable locality had previously been overlooked as in most cases the number of butterflies is very small. It would seem therefore that the butterflies reach any point on this long coast line and then collect at, or discover, practically all the groups of trees, remaining in numbers proportional to the suitability of the sites found. The migration is therefore merely to the coast, and not to particular small places.

TABLE 16.

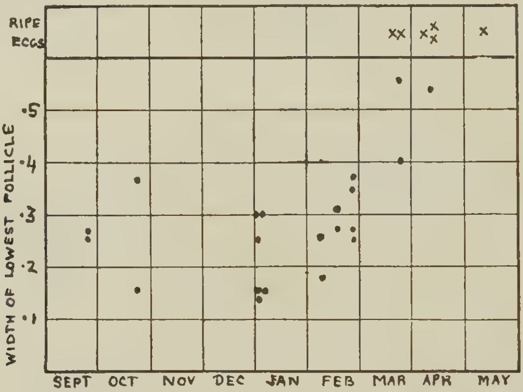
Presence of spermatophores (indicating pairing having taken place) in overwintering females of *D. plexippus* in California.

Date	Place	No. examined	No. with the following nos. of spermatophores					
			0	1	2	3	4	5
24 Oct., 1938	Pacific Grove	12	8	4	—	—	—	—
1 Jan., 1939	San Diego	7	3	3	1	—	—	—
7 Feb., 1939	Pacific Grove	5	1	4	—	—	—	—
17 Feb., 1938	El Cerrito	12	5	6	1	—	—	—
27 Feb., 1939	Pacific Grove	2	—	2	—	—	—	—
7 April, 1939	San Francisco	1	—	—	1	—	—	—
7 April, 1939	Stinson Beach	1	—	—	—	—	—	1
9 April, 1939	Pacific Grove	3	—	—	1	—	1	1

The resting sites are not chosen for their proximity to the larval food-plant, since, at least in all localities north of Pismo, Asclepias is absent or very rare for many miles around the trees chosen, as recorded by Williams for Pacific Grove. Also, not all sites are sufficiently far south to avoid a considerable mortality through unfavourable weather conditions. At El Cerrito, on 17th Feb. 1938, a cold and rainy day, many of the butterflies were numb and helpless, and when blown off the trees were either drowned in the puddles beneath or carried out into the Bay. Others were found dead on the ground, apparently killed by the cold. This sort of thing probably happens quite frequently as most of the chosen groups of trees are in such exposed windswept places.

The overwintering butterflies. On normal days, however, a small proportion of each group is active, flying around the trees, feeding at flowers, and occasionally mating. It is therefore slightly inaccurate to speak of the butterflies as hibernating. In the group of about 10,000 at Pacific Grove in the winter of 1938–39, feeding and mating were observed on all the visits made: Oct. 24 (10 pairs mating); Feb. 4 (7 pairs); Feb. 27 (5 pairs); Mar. 19 (5 pairs) and April 9 (2 pairs). A little more information can be extracted from Table 16 based on an examination of the bursa for the presence of spermatophores. This shows that mating had started by 24th Oct., soon after the arrival of the autumn migrants; that most butterflies had mated once by the end of the winter; and that in early April, just before the start of the spring migration, individuals that had already mated did so again fairly frequently.

In March and April, a greater proportion of each group becomes active, flying around and feeding at almost any available flower, but a nucleus of the cluster remains until at least mid-April (Pacific Grove). During this time, occasional butterflies were observed up to six miles away from the Pacific Grove colony on sunny days, and a similar wandering occurs around other centres, but it is not known if such butterflies ever return to the parent cluster, which is still existing. It seems likely that each individual goes through this active period before starting on the migration proper.



19

Fig. 19.—Width of the lowest follicle in the ovaries of overwintering *D. plexippus* in California arranged according to date of dissection.

The reproductive cycle during the winter is as follows.

I. The male. The spermatozoa are discharged from the testis into the vesicula seminalis and other parts of the genital ducts in elongate bundles each containing many spermatozoa. Spermatozoa in this condition are judged to be ripe.

A male bred from a Berkeley larva on 21st Sept. 1938, and dissected two days later, was found to have ripe sperm in the testis but none in the vesicula seminalis or in the lower part of the duct (the " paired gland " of Norris, 1932, *Proc. zool. Soc. Lond.* **1932** : 595). Two males taken at Pacific Grove on 25th Sept. 1938, before the arrival of the main mass of the migrants, had ripe sperm in testis, vesicula and paired gland; while the same was true of two other males from there examined on 24th Oct. 1938, about two weeks after the arrival of the migrants. A male was also examined on 5th Feb. 1939 (Pacific Grove), another on 31st March 1939 (Berkeley), and two on 8th May 1938 (Pacific Grove) : in the two former ripe sperm were present in testis, vesicula, and paired gland; in the latter the gland was not examined but sperm were found in both testis and vesicula. It appears therefore that ripe sperm occur in both testis and ducts very soon after emergence and before arrival of the migrants at Pacific Grove; and probably at all times during the winter until the spring migration.

II. The female. The overwintering female emerges from the pupa in September with all its egg-follicles quite small and unripe. They develop slowly during the winter months and the first females with ripe eggs (*i.e.*, eggs with the shell formed) were observed on 26th March 1938 at Pacific Grove. Table 17 shows something of the course of development of the ovaries as judged by the width of the lowest (ripest) egg-follicle. The female has eight ovarioles, all in very nearly the same stage of development, and the figures given are the averages of the eight measurements taken from each individual. These results are shown diagrammatically in fig. 19.

TABLE 17.

Development of ovaries as indicated by the width of the lowest egg-follicle in overwintering *D. plexippus* in California.

Date	Place	Width of lowest follicle
24 Sept., 1938	Berkeley (just emerged)	0·25 mm.
,,	,, ,,	0·26
24 Oct., 1938	Pacific Grove	0·16
,,	,,	0·37
1 Jan., 1939	San Diego	0·14
,,	,,	0·15
,,	,,	0·15
,,	,,	0·25
,,	,,	0·30
,,	,,	0·30
7 Feb., 1939	Pacific Grove	0·19
,,	,,	0·25
17 Feb., 1939	El Cerrito	0·28
,,	,,	0·31
27 Feb., 1939	Pacific Grove	0·25
,,	,,	0·28
,,	,,	0·35
,,	,,	0·37
26 Mar., 1938	,,	0·41
,,	,,	0·55
,,	,,	1 ripe egg
,,	,,	6 ripe eggs
7 April, 1939	Stinson Beach	7 ripe eggs
9 April, 1939	Pacific Grove	0·53 mm.
,,	,,	1 ripe egg
,,	,,	5 ripe eggs
8 May, 1938	,,	1 ripe egg

It will be seen that there is only a very slight increase in egg-size until the end of February, followed by a stage of rapid growth in early March, for which period there are unfortunately no records. Growth during the winter months is, however, more active than would appear from the table, as it is being offset by an opposite process of egg degeneration, which continually destroys the largest follicles during this period. In some cases this degeneration at the lower end of the ovariole goes on faster than the upper eggs are growing: this accounts for those winter records in which the lowest egg is smaller than it is in newly emerged butterflies. The eggs are ripe and ready for laying from late March and early April onwards. No case was found of an overwintering individual that had laid eggs before the winter; always the plug separating the ovariole proper from the oviduct was intact until the spring. It will also be seen that most females have already mated when their eggs were quite unripe; it is not known whether a second mating, in spring, is necessary, but as shown above such a mating commonly takes place.

The migrations. The autumn migration to the Californian coast takes place usually in early October, but possibly is not complete until a month or more later. I have no exact records of the time of arrival of the butterflies at their overwintering sites, and the comparative scarcity of records of large flights in the West makes one suspect it is not always carried out by compact masses of butterflies as it is in the East. The males have at this time ripe sperm in both testes and ducts, while the females have the egg-follicles quite immature, hardly larger than they were in emergence, and degeneration is already setting in. Mating has either just started or will do so very soon.

As there are no discoverable records of the butterfly in inland California during the winter months the migration would seem to be complete, except for any females in egg-laying condition, which, as they never arrive at the coast, presumably die inland before the winter.

The spring migration is certainly spread over a considerable period, and is carried out by butterflies moving more or less alone. The time of its start can be judged only from indirect observations. A female with 4 ripe eggs in each ovariole was taken at Alum Rock Park, Santa Clara Co., about 50 miles from the coast on 9th April 1938, and a dozen others were seen at the same place and time. Four males were taken in Owens Valley, some 200 miles inland, on 17th April 1938. On 14th May 1939 in the Yosemite Valley a well-grown larva was found; this pupated on 22nd May and emerged 9th June. The egg from which it developed had been laid probably about 20th April. Five newly-emerged adults, however, were found on 4th June at Mariposa; these must have come from eggs laid about 12th April. On 12th June adults and just-hatched second generation larvae were found east of Reno, Nevada, indicating that the migrants had penetrated about 250 miles inland by mid-April. All these data point to the fact that the spring migration is in progress in early April, and that the whole of California is repopulated by the middle of the month. The later discussion on the change in sex-ratio in the Pacific Grove colony will show that the first migrants probably leave in March. Many butterflies, however, are still at Pacific Grove in mid-April, and as will be seen some are still there as late as 8th May. It is indeed possible that the spring migration is never quite complete, as butterflies can be seen around Berkeley, 1–2 miles from the El Cerrito wintering site, at all times of the summer; these may, however, be individuals that have wintered farther south and performed a normal migration.

It seems therefore that the first butterflies migrate very soon after the eggs have begun to ripen, and that the others do so during the month (April) in which ripe eggs are to be found in those females that still remain at the overwintering places. The males migrate with ripe sperm in both testes and ducts. The reproductive condition of the males is thus seen to be the same, while that of the females is very different, on the two journeys.

This account of the migrations was written from data obtained at Pacific Grove and northwards, and it is likely that the migration begins somewhat earlier farther south. Also, although in general the reproductive condition of the butterflies is the same in both southern and northern localities throughout the winter, as shown by the undeveloped condition of the San Diego females, exceptionally a southern female is found to be mature during the winter months. Thus two specimens were bred on 4th April and 7th April 1931 from eggs laid in the wild at Fullerton, Orange Co., in December 1930 (Mr. J. W. Johnson), and females taken after their arrival at overwintering places near San Diego in November 1936 laid eggs after two weeks in captivity (Capt. Medlar). The migrating instincts of such unusual individuals are not known.

The sex-ratio of the overwintering butterflies. In most localities males and females occur in more or less equal numbers during the winter months. Fifteen males and 14 females were observed at San Diego, 1st Jan. 1939, and 10 males and 21 females at El Cerrito, 17th Feb. 1938. At the Pacific Grove colony, however, males consistently outnumbered females in both the 1937–38 and the 1938–39 season, and from the beginning of March onwards the proportion of females decreased still further until very few could be found, while the males remained in thousands until at least 8th May. The figures for those actually caught and sexed are as follows (the two seasons' records being combined).

Date	Males	Females	Ratio m. : f.
24 Oct., 1938	54	26	2·1 : 1
4 Feb., 1939	51	29	1·8 : 1
27 Feb., 1939	41	14	2·9 : 1
19 Mar., 1939	12	2	6·0 : 1
26 Mar., 1938	100	8	12·5 : 1
9 Apr., 1939	35	4	8·8 : 1
8 May, 1938	27	1	27·0 : 1

Actually, the proportions on 26th March and 8th May 1938 were much more extreme than they appear from the table. Almost all the females seen on those days were mating, and it was apparent that the many single specimens were nearly always males. In all probability the sex-ratio on 26th March was of the order of 100 : 1 and on 8th May 1000 : 1. It is not known whether these males eventually migrated or whether they died at Pacific Grove. It is clear, however, that the spring migration of most groups is carried out by males and females together, and as noted above, males were found in Owens Valley, 17th April 1938. This unusual phenomenon at Pacific Grove is quite without an explanation.

Note by C. B. Williams :—As additional information on this point I may add that in the spring of 1932 at St. Paul, Minnesota, the first Monarch of the year that I captured on 30th May was a male, and of three others captured within the next week one was also a male. There is therefore positive evidence that both sexes migrate north simultaneously in the spring.

D. plexippus, migrations in North and Central America and the West Indies.

By C. B. Williams.

Since my last summary of the migrations of this butterfly (Williams 1938b) a number of additional records have come in which are summarised below.

United States of America.

Alabama. In September 1936 Monarchs were observed in rather large numbers at Auburn by H. S. Swingle.

In the autumn of 1937 they were observed at Montgomery, moving to the S.E. with many *C. eubule* and *D. vanillae*, by P. H. Smyth.

Arkansas. Mr. A. M. Merrill of Rogers, Ark., writes: "*Anosia plexippus* passes through here in October and is usually scudding before a cold north wind, and very high in the clouds. Usually before the great hosts arrive there will be thousands flying slowly near the ground, and a little south by south-east. These take their time and often rest at night on tree limbs in such weights as to bend the limb almost to the ground. When a 'northerner'[2] strikes they rise and go with it night and day till they reach warmer weather. Sometimes they are accompanied by *Pyrrhanaea andria* in their high flights. . . . One night in October 1921 I went out into the yard to view the moon. I had a three-inch telescope and the wind blew hard from the north. In looking at the moon we saw thousands of *Anosia* and *Pyrrhanaeas* passing over the field of the telescope. They numbered probably millions but could only be seen as they neared the light of the moon."

California. The most northerly point at which I have records of hibernation of Monarchs is on the coast just north of San Francisco at Stinson Beach and Bolinas.

At Stinson Beach Mrs. Atherton-Coleman writes that in 1937 they arrived in late summer and remained until March 1938, hanging thick about the Eucalyptus and Escallonias. During March they broke up and by the 4th April only a few bedraggled specimens with broken wings were seen here and there. She writes: "I cannot help noticing their fondness for the coast; inland they seem scarce."

In 1938 they began to arrive about the end of October and swarmed all through November.

At the Bolinas, according to Mr. A. R. Duperu, they appeared about 1st September 1937. In November 1937, Mr. Duperu sent 50 specimens which included 29 males and 21 females. The butterflies left during March and only a few stragglers were present on the 1st April. In 1938–39 they arrived during August and left about 31st March.

At Pacific Grove, Monterey, many observations have already been recorded. In the autumn of 1937, according to Mr. Alan Forbes, the butterflies arrived about the 10th–20th October. He says, "I was not able to observe any massed arrival, the butterflies increased day by day, noticeably." On the other hand, he quotes a record from the previous year (1936) when they were seen by an observer to arrive in a swarm about five o'clock in the evening from the direction of Santa Cruz (north).

During October and November five or six mating pairs were seen, and again during March 1938 when Mr. Forbes sent me four pairs captured when mating. In the spring of 1938 they began to leave about the 25th March. By the 20th April there were still plenty about but they were more and more scattered. On 18th October 1937 Mr. Forbes sent me 21 specimens which included only 3 females, and on 8th March 1938 a dozen more (apart from the four pairs) which included only 3 females (see p. 165).

In the autumn of 1938 they were observed by Miss M. Bondfield. "They began to arrive on Saturday, 8th October, just a few. On Sunday 9th the swarm was beginning to settle on the trees and they were already an astonishing sight. On 10th October the whole swarm had practically arrived, as only an occasional one could still be seen in the air."

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[2] A cold wind from the north.

A full account of Mr. J. A. Downes' observations at this locality will be found on p. 160.

Two new records of directional flights are also available for California. In August 1912, at Marble Mts., Siskyou County, California (according to a record from Mr. Alan Forbes), an observer at the summit of the pass, much lower than the surrounding mountains, suddenly came upon an amazing line of butterflies. They were coming up the slope as far as could be seen, then crossing the summit and immediately descending in line far beyond vision. The flight was watched for half an hour and was still passing " in countless millions." Nearly all were from 10 to 20 feet above the ground and they never alighted.

In mid or late September in 1917 or 1918, near Los Angeles, Mr. P. M. Gillmer saw a big scattered flight one evening about sundown. One individual every 20–30 feet in all directions and up to at least 100 feet high. The general direction of the movement was to the south. It was said to be a regular occurrence in the district.

Connecticut. Britton (1934, *Rept. Conn. State Ent.* : 251) says that in 1934 the Monarch was unusually common and thousands were seen clustered on the trees at Sacham Head, Guildford, on 20th August. They settled at 7–7.30 p.m. and resumed flight the next morning.

District of Columbia. According to a letter from Dr. E. Murray-Aaron, a flight was observed in Washington, D.C., by Dr. Ashmead at the end of September 1893.

Florida. Notes on the occurrence of the Monarch in Florida as observed by Mr. and Mrs. K. Hodges will be found on p. 147.

Mrs. W. G. Colvin, writing from Davenport, Florida, says that in the fall of 1937 the first was seen on 20th November, another about a week later, and then one or two others. Then came a frost which killed the Poinsettias and until the end of March 1938 not one was seen. " Never seen so few butterflies for 11 years."

In the fall of 1938 they began to arrive early in November and were seen in moderate numbers up to the 3rd February. Mrs. Colvin writes that no Monarchs are seen except during the winter months.

At Englewood (on the west coast of Florida) Mr. W. F. Smith reports about 47 seen in December 1937, but none from 1st January to 4th April 1938, including observations made on a trip to the extreme south of Florida at the end of January. In the fall of 1938, 14 were seen between 22nd and 30th November, 87 in December and 36 in the first three weeks in January. In December 1938 Mr. Smith marked several Monarchs by clipping their wings. The longest period during which any one was observed was 11 days.

Georgia. Mr. T. L. Bissell writes (in 1937), " About five years ago (*i.e.*, about 1932) at Experiment, Georgia, I saw about 200–300 Monarchs moving round a water tank and adjacent trees one day in the fall. They were about 50 feet in the air."

In the fall of 1933 L. Harris observed a noticeable flight towards the S.E. at Atalanta, Georgia. The butterflies were flying high in the air, often several visible at once from the ninth floor of an office building.

At the end of September and beginning of October 1934 and 1935, congregations were observed at Marietta, according to Mr. W. A. Ruffin.

Illinois. Shannon (1935) on map p. 157 records flights to the south at Winchester, Illinois, for 25 years.

In the fall of 1934, Dr. E. Murray-Aaron observed desultory stragglers in small flights of a few dozen to some hundreds over the Skokee Marshes, north of Chicago.

On 5th September 1934, according to Mr. P. Viosca, thousands of large butterflies, believed to be Monarchs, appeared high in the air round the lights of the Chicago Exhibition.

Indiana. On the 6th September 1934 during a cold north-east wind, hundreds of Monarchs were found clustered in trees on the Indiana Dunes State Park on the south shores of Lake Michigan, according to P. Viosca.

On 20th September 1937, at New Haven, Ind., Mr. C. Fredrickson observed a migration of Monarchs to the south about one mile from the town. About 500–1000 individuals were flying about 6 feet from the ground with a N.W. wind. It was growing dusk and temperature about 75° F.

Iowa. Mr. F. Braillian writes that in the first weeks of May 1884, in Iowa he saw large numbers of Monarchs flying to the north. This is one of the few records of the mass flight to the north in the spring.

In late September 1916, according to Shannon (1935, map p. 157), there was a flight to the south at Alexandria, which appears to be in either S.E. Iowa or N.E. Missouri.

Kansas. Prof. H. R. Bryson writes (Dec. 1937), " We notice migrations of the Monarch at Manhattan, Kansas, in October. Usually they go almost straight south. They may arrive at 10 a.m. and all be gone by 1.30 or 2.0 p.m. I recall last fall (1936) counting 23 at one time on a Morning Glory vine at noon, but all had gone by 2 p.m."

Smith and Kelley (1938) report that the first individuals of 1937 were seen in Eastern Kansas on 15th June and in Riley Co. on 21st June.

Kentucky. Mr. W. A. Price writes (Nov. 1937), " Nearly every year from 22nd to 30th September Prof. Garman and Miss Didlake have noted these insects from the windows of the laboratory at Lexington, Ky., not crowded but scattered individuals always flying southwards."

Mr. C. O. Eddy writes that he has observed similar flights at Lexington for a number of years. Huge migrations take place which extend at least for several miles on each side of the town. The mass movements are usually over in two or three days but may last about a week. Once he saw one just as a storm was coming up. The butterflies massed on the sheltered side of a tree but did not settle until the rain began. They then flew towards refuge places under the limbs and lighted on leaves, stems and bark.

On 30th September 1933, at Camp Nelson, about 20 miles south of Lexington, hundreds were observed settled on the limbs of a Sugar Maple tree by Prof. H. Garman and Miss M. Didlake.

On 20th October 1934 great numbers were observed going to the south at Lexington by Mr. W. A. Price.

Louisiana. Mr. P. Viosca writes : " Although Monarchs are absent in the deep south during the summer months, they arrive along the Gulf coast in numbers during October and November, apparently with northerly winds. *Danaus berenice*, although only a small percentage of the total, takes part in the migration. If the weather moderates after they reach the Gulf coast they linger awhile and even lay eggs. On one occasion I observed a full crop of caterpillars on a species of Milkweed near New Orleans. After this migration we do not see any more throughout the winter."

In 1934, on 20th and 27th October, Mr. Viosca saw small numbers flying to the south over Lake Pontcharitrain, north-east of New Orleans, and on the 26th in New Orleans itself.

In November 1937 Mr. Viosca captured 57 specimens in St. Tammany Parish and sent them to Dr. A. H. Clark at Washington, who reported that 3 males and 1 female were of the *nigrippus* form.

In 1930 the first Monarch of the spring was seen on 26th March and the first of the autumn on 20th September. After this none was seen until 8th October and then occasional individuals throughout October; all these were in the New Orleans area.

On the other hand, Dr. P. B. Hussey, D. C. Elliott and H. A. Jaynes write that they have never observed mass movements in Louisiana.

Maryland. At the end of September 1893 a swarm was observed at Baltimore by Dr. Uhler, according to information received from Dr. E. Murray-Aaron.

In 1937, according to E. N. Cory (1937), they began to assemble at Piney Point, St. Mary's Co., on 7th October, and by the following day over 500 had assembled in the neighbourhood. He sprayed them with a green dye, but has not recorded any recaptures.

Massachusetts. Mr. W. T. M. Forbes reports that in 1899, 1900 and 1901 at Worcester, Mass., the Monarchs gathered each fall in a beech tree at the foot of his grounds, hung about for a few days and then disappeared all at once. There were only about a thousand and invariably on the one tree. He suggests that they were gathering here from the surrounding square mile or so preparatory to moving south.

According to Mr. K. Merrill, Monarchs appeared in great numbers on Great Misery Island, off Manchester, Mass., at the end of August in 1934 and 1936. They did not appear in numbers on the mainland until about two weeks later.

Mississippi. Mr. C. Lyle writes that in 1923 at the end of October or early November he observed large concentrations of Monarchs massing on low-hanging, moss-draped branches of live-oak. This was on the Gulf coast of Mississippi about 6 or 7 miles west of the city of Bay St. Louis and only a few yards from the shore. They showed no signs of fear, and large numbers could be captured by hand.

At the same time large numbers were observed flying from east to west at Bay St. Louis, while equally large numbers of *C. eubule* were flying towards the east.

New Jersey. Dr. E. Murray-Aaron records that on 25th and 26th September 1893 at Frenchtown, N.J., on the Delaware River about 30 miles north of Trenton, he saw a migration of Monarchs heading to the south for two days, following the course of the river, and flying against a steady head wind.

New Mexico. Mr. P. R. Gleason, writing September 1939, says that in June 1939 he saw no Monarchs, in July only one and in August about three.

New York State. In September 1920 Mr. V. D. Carr observed large numbers of Monarchs near Rochester settling on a dead oak about 35–40 feet high. All small branches and many of the larger were covered with butterflies. Some were coming in from the north from over the lake.

In September 1935 Mr. Carr observed a flight from the north at Port Bay, about 50 miles east of Rochester. These made two sharp turns over the water (see discussion on p. 226). Many thousands passed in a narrow belt only 10–12 feet wide.

One day in mid-September 1935, according to Mrs. L. B. Unkefer at Endicott, N.Y., the air was filled with butterflies going to the south-west. Not a compact swarm but always many visible : mostly 10–20 feet up, and flying nearly against the wind.

Mr. Mahuken reports that in the fall of the same year they were moving south in New York City, and again in the first half of September 1939; they were going south-west in most cases against a wind of about 10 m.p.h. None was noticed there in 1936, 1937 or 1939.

North Carolina. Mr. C. S. Brimley writes that some time before 1919 in the springtime in North Carolina some boys brought him a number of Monarchs with the statement that there were quantities more in a clover field then in bloom. It was probably in April.

Mr. F. Sherman writes that in the autumn of 1920 he saw a definite flight at Raleigh, N.C.; each minute 20–30 would cross a front of 100 yards, the great majority going from north to south.

Mr. R. Dayton writes that at the beginning of October 1935 at Carolina Beach, 15 miles south of Wilmington, N.C., he saw a slight movement of Monarchs towards the south along with *P. eubule.* He adds that some stayed so late that they were paralysed with the cold and could be picked up by hand.

Pennsylvania. At the end of September 1893 for 3 or 4 days at Fairmount Park, Philadelphia, Dr. H. Skinner observed numbers of Monarchs congregating (according to E. Murray-Aaron).

South Carolina. Mr. F. Sherman writes that for 37 years he has worked chiefly in the two adjoining states of N. and S. Carolina. The Monarch becomes more abundant and conspicuous in the fall than at any other time, and the drift of flight seems to be southerly. The adults appear again in spring in fewer numbers and most appear worn, faded and often tattered. The drift northward in the spring does not seem so well defined as the southward drift in the autumn.

Mr. O. L. Cartwright reports that on 4th October 1934, between Walhalla and Clemson, S.C., Monarchs were seen about 10–25 per mile of road, all flying slowly to the south about 3–6 feet above the ground. Ninety-five were counted in 5 miles.

Mr. J. A. Berly writes that he has never seen any large migration in South Carolina but that each fall they appear to be travelling to the south.

Tennessee. Dr. E. Murray-Aaron records that in the autumn of both 1874 and ?1879 he saw flights of Monarchs in the Smoky Mountains between North Carolina and Tennessee. They were flying towards the south-east, passing through the gap of the Little Tennessee River.

Many years later Mr. G. M. Bentley observed a great congregation in the same area. He writes: " About 1929, in the Smoky Mountains, after a rain storm, trees were seen weighed down with butterflies, so that the lower limbs bent down 4–5 feet to touch the ground. About 10 a.m. the next day the butterflies began to detach themselves, flying round a little till myriads were flying in a hesitating flight to south and west."

Mr. Bentley notes that regular flights to the south occur in the State from mid-October to mid-November.

Mr. F. Braillian writes that on the Sequatchie Valley not far from Ohattanovga, Tenn., " there is an almost perpendicular rock wall, several hundred feet high, that practically locks the fall migration of the Monarch, and they sometimes gather together in a cove against the wall by thousands. Usually they finally find their way out and complete their migration, but I had a report two or three years ago from a man living there that severe freezing weather came before several thousand of these butterflies had found their way out and apparently killed them all."

At Bolivar observations were taken by Mr. C. McR. Plummer in 1938 and 1939. In October of 1938 he saw a few only travelling to south-east. In

October 1939 the first was seen on 12th October and in the last week small numbers were going chiefly to the south.

Texas. E. Murray-Aaron writes that in 1884, probably in early October, he saw numbers of Monarchs coming in over the sea at Corpus Christi.

In the same locality in 1938 Mr. B. Struck observed many Monarchs flying to the south from the 10th to 14th November. He states that he has observed this southward movement in Texas for some years but never in very large numbers.

Canada.

According to Mr. K. Bowman, a large congregation and migration to the south was noted by Mr. D. Gregson at Blackfalds, Alberta, in the " late nineties." Blackfalds is about 100 miles south of Edmonton.

Mexico.

Through the kindness of Dr. E. Murray-Aaron I am able to record that in 1890 the late Sir Rider Haggard observed a flight of thousands of Monarchs towards the south in Orizaba, Mexico. Dr. Aaron met him a few days later and confirmed the identification from some specimens that he had captured. This is the only record of flight at present known in Mexico.

Porto Rico.

F. Sein (1929) describes a flight of Monarchs flying towards the east in Porto Rico in " November " but gives no date or exact locality.

Mr. J. I. Otero reports to Mr. G. N. Wolcott that the flight was in 1928 and that he first noticed Monarchs in San Juan flying against the N.E. trade wind (*i.e.*, from south-west to north-east) about a month after the hurricane of San Felipe, which was on the 13th Sept. 1928. The same day he noticed them also at Santurce and Rio Piedras. Most were at a considerable elevation and only a few came down to the ground. The flight lasted for about a week.

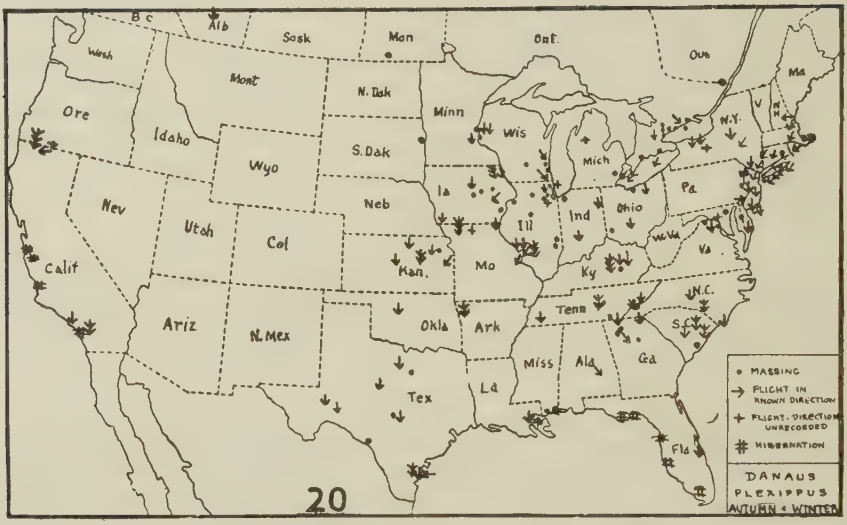
Mr. W. A. Hoffmann, referring to what he thinks is the same flight, says, however, that the butterflies seemed to be following the north coast and going in a westerly direction. Innumerable butterflies passed on one day and a few stragglers on the next.

General Summary.

In the map (fig. 20) and the diagram (fig. 21) will be found summarised all the available data on the dates, localities and direction of flights in North America.

From the map (which shows only the autumn flights) it will be seen that there is a general southerly movement over the whole of the eastern half of the U.S.A. and the great Mississippi Valley, and again movement along the Pacific coast. There is no evidence of mass migration through the mountainous belt of the Rockies.

Hibernation is recorded in Southern California and in Florida. The butterflies which pass south through Texas appear to carry on into Mexico, where I have only one single record of a southward migration (see above) and none of mass hibernation. In Louisiana there are at present no records of hibernation and some evidence that the butterflies are absent both in summer and winter: that is to say, are " birds of passage " only.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MASSING
FLIGHT IN KNOWN DIRECTION
FLIGHT-DIRECTION UNRECORDED
HIBERNATION
DANAUS PLEXIPPUS AUTUMN + WINTER
20

FIG. 20.—Recorded flights and hibernating localities of *D. plexippus* in North America.

From the geographical distribution of the races (p. 158) it seems possible that the North American migrant may cross the sea to the larger West Indian Islands, Cuba and Haiti and perhaps Jamaica, but it is unlikely that they go any farther across the Caribbean Sea.

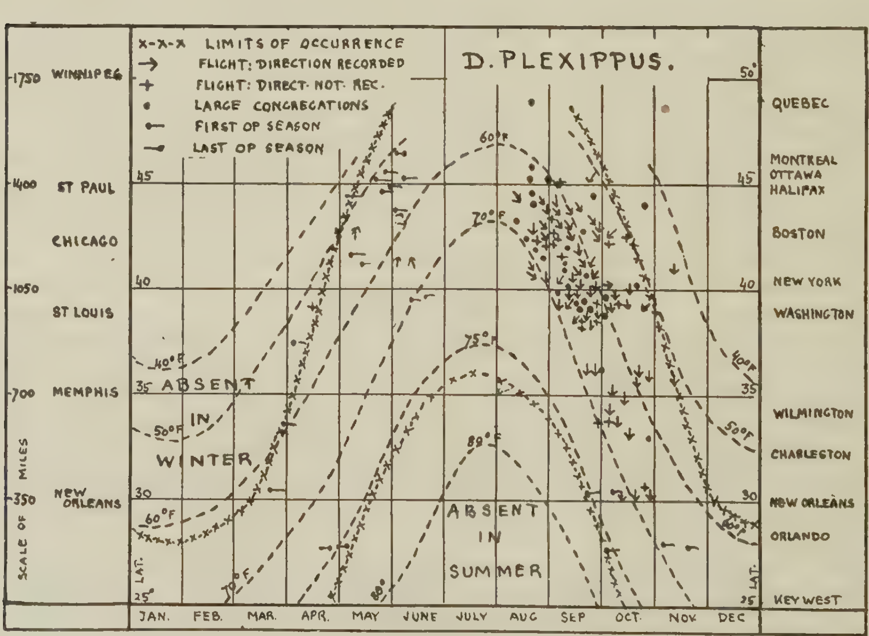

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FIG. 21.—Diagram showing the movements of *D. plexippus* in eastern North America according to time of year and latitude.

The diagram (fig. 21) is an attempt to show movements both in time and distance, north and south, in the same figure. Each recorded flight is put in in its corresponding date and latitude. Superimposed on the flight records are the isotherms for the mean temperature. It will be seen that the last butterflies appear to leave Florida in the spring when the mean temperature rises above 75° F. and they begin to return at about the same temperature level. There is definite evidence in Florida of a period of summer absence. Possibly, however, they persist farther north, in Georgia, and in N. and S. Carolina, with mean temperature above 75° F.

They do not seem to arrive in the north until the mean is over 50° F. and leave again before the mean falls below the same level. They move both south and north more rapidly than the isotherms, with the result that they are moving steadily into cooler climates as they go north in the spring and into warmer ones as they go south in the autumn.

The most important points now to be settled are to find how far north the zone of complete absence extends in the summer; how far north winter hibernation can occur; and hence what is the extent of the area (which seems to exist in Louisiana) in which the butterflies appear only in spring and autumn. More observations in Mexico and Central America are specially needed.

Migrations in S. America (*D. erippus*).

In my previous summary only two records of flight were given; both seen by Hayward in the Argentine Republic in March and April and both towards the north. They were therefore moving towards the Equator in the autumn.

Dr. Malcolm Burr informs me that he saw a big flight of this butterfly at the mouth of the River Plate, near Buenos Aires, at the beginning of April 1891. From his notebook the following extracts are taken :—

" 2 April 1891—Today a swarm of big butterflies came off from the shore and I was all the time catching them. With others to help me I got 68 specimens.

" 3 April. Today we caught another.

" 4 April. Today we caught some more, making the total 72."

He had arrived in Buenos Aires on 21st March and left on 6th April but was unable to go ashore owing to quarantine. No note was made at the time of the exact direction of flight.

A. Wetmore (1926) states that he has observed migrational movements of *D. erippus* " that wintered in numbers in the Chaco and in the spring flew southward to spread over the pampas." The Chaco is in north Argentine and the adjoining portions of Bolivia and Paraguay. In a letter he adds : " I first observed *D. erippus* in July and August in the Chaco. The insect was very common here. . . . In October I saw them moving down into the open Pampas Country to the south and observed them occasionally throughout the summer. In February, in Uruguay, they were again in evidence. I did not see the great migratory flights in S. America that I have watched on occasion in U.S.A."

In addition to the above records of directional flight there are two records of the capture of the insect out at sea in the Atlantic. In the British Museum is a specimen labelled " 23 February 1931, at sea 60 miles off Rio Plata, Brazil " captured by W. W. Holmes on H.M.S. *Eagle*. On 20th February 1939, a female was captured on S.S. *Alcantara* when in Lat. 12° 22′ N., Long. 27° 01′ West while on a voyage from S. America to Europe. This is only about 200 miles south of the Cape Verde Islands and much nearer to Africa than to S.

America. The specimen was sent to me by Mr. E. M. Barker. It is remarkable that a S. American *erippus* should be found so far from shore when the Monarchs caught in the Cape Verde, Canaries and Azores are all typical N. American forms.

D. plexippus in Great Britain.

In the past sixty-four years, 57 individuals of *D. plexippus* have been captured in England, Wales and Ireland and a further 94 reported as having been seen but not captured. No specimen has been reported from Scotland.*

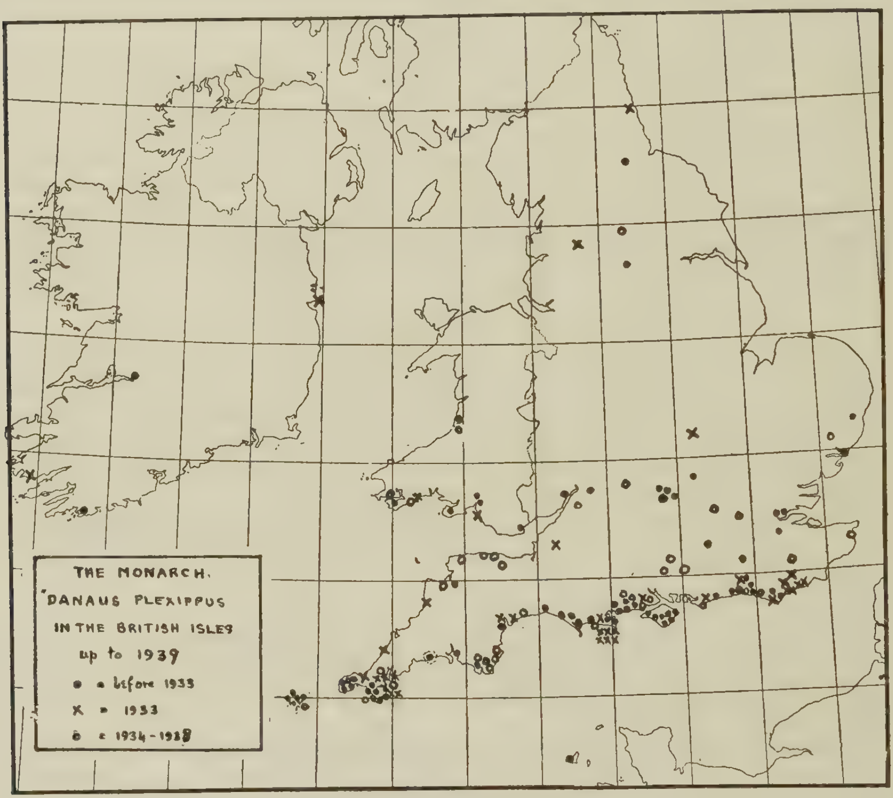

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Fig. 22.—Map showing the position of records of *D. plexippus* in the British Isles.

Brief details of all those captured together with the first reference traced for each are given in Table 18. The localities of capture are all marked on the map (fig. 22).

It will be seen that the great majority are along the south coast of England, with a few along the south coast of Wales and Ireland and only a relatively small number inland. The farthest north capture is one in Co. Durham in Sept. 1933.*

The capture of Monarchs each year in Britain is shown diagrammatically

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* Since this was written one has been captured in the Shetland Islands, see Table 18 no. 151.

Table 18.

List of British records of *D. plexippus.*

1. **1876, Sept. 6. Neath, Glamorgan.**
Female caught by J. Stafford (J. D. Llewelyn, *Ent. mon. Mag.* **13** : 108) seen alive by Llewelyn. Now in British Museum.

2. **1876, Sept., 2nd week. Keymer, Sussex.**
One caught by A. Wood (F. Bond, *Entomologist* **10** : 73).

3. **1876, Oct. Haywards Heath, Sussex.**
Female caught by a labourer (T. E. Crallan, *Entomologist* **9** : 265). Identity checked by J. J. Weir and Douglas. " Female of North American form." " Lower wings still wrinkled and not long out of chrysalis."

4. **(1876). Poole, Dorset.**
One caught by a coastguard and seen in a wall case by Eaton (A. E. Eaton, *Ent. mon. Mag.* **22** : 161).

5. **1881, Sept. 21. Snodland, nr. Maidstone, Kent.**
One caught by F. J. Hawes (J. J. Weir, *Entomologist* **19** : 12).

6. **1884, Sept. 12. Ventnor, Isle of Wight.**
One caught by a newspaper boy and bought by Westropp (D. Westropp, *Ent. mon. Mag.* **21** : 202).

7. **1885, Aug. Exmouth, Devon.**
One caught by a " friend of a cabman," seen by Hellins (J. Hellins, *Ent. mon. Mag.* **22** : 211).

8. **1885, Sept. early. Ventnor, Isle of Wight.**
One seen by L. Arnold; flew within a foot of observer (J. J. Weir, *Entomologist* **18** : 305).

9. **1885, Sept. 17. Nr. Lizard, Cornwall.**
Caught by A. H. Jenkin (*Entomologist* **18** : 291). Now in Truro Museum. Locality given later as " Carthillian Cove."

10–11. **1885, Sept. 21. Trevilley, Cornwall.**
One caught and one seen by H. Saundry (R. J. Anderson, *Entomologist* **18** : 290). Seen by Barrett (*Brit. Lep.* **1** : 114).

12–13. **1885, Sept. 24. Housel Bay, Lizard, Cornwall.**
Two caught by A. H. Jenkin (*Entomologist* **18** : 291). Now in Truro Museum.

14. **1885, Sept. 25. Plymouth, Devon.**
One caught by F. F. Freeman (1885, *Proc. ent. Soc. Lond.* : xxv). Seen alive by G. F. Mathew on day after capture (*Entomologist* **54** : 211); also referred to by Walker (*Ent. mon. Mag.* **50** : 290).

Walker (*Ent. mon. Mag.* **50** : 227) refers to a specimen said to have been caught at " Downderry, Cornwall " by Freeman on the same date as the above and gives the reference to the *Proc. ent. Soc.* as above. It is practically certain that Freeman did not catch two specimens on the same day, and all evidence points to Plymouth as the correct locality. The first reference I have found to " Downderry " is that by Walker in 1914, thirty years after the supposed capture. Where his information came from I cannot trace. See also no. 26.

15. **1885, Sept. 26. Parkstone, nr. Poole, Dorset.**
One caught by T. G. Cuthell (*Ent. mon. Mag.* **22** : 134).

16. **1885, Sept. 29. Nr. Lizard, Cornwall.**
One seen by A. H. Jenkin (*Entomologist* **18** : 291). Locality later given as Housel Bay.

17. **1885, Sept., end. Castel Martin, Pembroke.**
One caught by T. Mousley and given to Wilkinson (C. Wilkinson, *Entomologist* **19** : 298).

18. **1886, Aug. 14. Lyme Regis, Dorset.**
One female caught by N. V. Sidgwick (J. J. Walker, *Ent. mon. Mag.* **50** : 290). Now in Hope Department, Oxford.

19. **1886, Aug. 19. Swanage, Dorset.**
One caught by J. E. Mowlem (*Entomologist* **19** : 247).

20. **1886 (Sept. early). Swanage, Dorset.**
One caught by a cottager and given to Stenning early in September, but not definitely stated when it was caught (G. C. Stenning, *Entomologist* **19** : 277).

21. **1886, Sept. 30. Bournemouth, Hants.**
One male caught by T. Watts and given to W. McRae (McRae, *Entomologist* **19** : 277).

TABLE 18 (*Continued*).

22. **1886, Sept. Glanafon, Glamorgan.**
One caught by H. W. Vivian (R. M. Richardson, *Ent. mon. Mag.* **50** : 249). In 1914 in Nat. Mus. Wales, Cardiff.

23. **1886, Sept. or Oct. Housel Bay, Lizard, Cornwall.**
One seen by A. H. Jenkin (*Entomologist* **19** : 276).

24. **1886, Oct. 2. St. Peters Port, Guernsey, Channel Is.**
One caught by A. H. Collings (W. A. Luff, *Entomologist* **19** : 278).

25. **1886, —. Shanklin, Isle of Wight.**
One caught by J. A. Billings (*Entomologist* **20** : 39, quoting a newspaper).

26. **1886, —. Cornwall.**
Specimen in Nat. Mus. Wales at Cardiff with this data, from coll. H. W. Vivian, according to N. M. Richardson (1914, *Ent. mon. Mag.* **50** : 249). In the minutes of the meeting of the Entomological Society held on 6th October 1886 there is a statement that Mr. F. F. Freeman reported the capture of a specimen of *D. plexippus* in Cornwall. This record does not appear in the published *Proceedings* of the meeting. The specimen referred to may be that now at Cardiff.

27. **1887, Sept. 14. Worthing, Sussex.**
One caught by F. H. Stewart (*Entomologist* **21** : 321).

28. **1887, Sept. 15. Worthing, Sussex.**
One seen by F. H. Stewart (*Entomologist* **21** : 321).

29. **1888, —. Penarth Dock, Glamorgan.**
One caught (Hallett, 1917, *Trans. Cardiff Nat. Hist. Soc.* **50** : 48).

30. **1890, Oct. 2. Eastbourne, Sussex.**
One seen by A. H. Clarke (*Ent. mon. Mag.* **26** : 327); flew out to sea.

31. **1894, Aug. Brighton, Sussex.**
One seen by W. E. Blackiston, from his diary and " contemporary newspaper " (T. Dannreuther, 1935, *Entomologist* **68** : 136).

32. **(1894.) Aylesbury, Buckinghamshire.**
One seen about this year by W. Crouch (F. W. Frohawk, 1915, *Entomologist* **48** : 266).

33. **(1895.) Shanklin, Isle of Wight.**
One captured by a visitor (Poole, in Morley's *Guide to Nat. Hist. of Isle of Wight* : 398).

34. **1896, May 28. Lymington, Hants.**
One seen by E. G. B. Meade-Waldo (6.v.1896, *The Field* **87** : 856; also *Entomologist* **29** : 216). Recorded as *chrysippus* but editorial says probably *plexippus*.

35. **1896, June 12. Newlands Corner, Surrey.**
One seen by a friend (W. J. Lucas, *Entomologist* **30** : 18), recorded as *menippe*.

36. **1896, Aug. Newchurch, Isle of Wight.**
One seen by W. S. Worsley-Benison (*Ent. mon. Mag.* **38** : 113).

37. **1896, Sept. Lizard, Cornwall.**
One seen by Miss Jenkin (A. P. Jenkin, *Entomologist* **29** : 365).

38. **1899, —. Weymouth, Dorset.**
One caught by G. and J. Joliffe. Wings found in a curiosity shop and purchased by N. M. Richardson (*Ent. mon. Mag.* **50** : 249).

39. **1906, Sept. 29. Felixstowe, Suffolk.**
One seen by T. Barrett (1906, *Country Side* : 275, see also T. S. Barrett, *Trans. Suffolk N.H. Soc.* **1** : 30).

40. **1908, —. North Oxford.**
One caught by a gardener and brought to Rev. M. Merry (J. J. Walker, *Ent. mon. Mag.* **64** : 90).

41. **1908, Sept. 13. Culver Cliffs, Isle of Wight.**
One found lying dead on grass, but not yet stiff, by G. H. Heath (*Ent. Rec.* **20** : 237).

42. **1910, Autumn. North Oxford.**
One male captured by a young lady (J. J. Walker, *Ent. mon. Mag.* **64** : 90). Now in Hope Dept. Oxford. Male of N. American type.

43. **1916, Oct. 20. Castle Townsend, Co. Cork, Ireland.**
One caught by H. Chevasse (4.xi.1916, *The Field* **128** : 714; see also F. W. Frohawk, *Entomologist* **49** : 285). Now in coll. F. W. Frohawk. Female, figured in Frohawk's *Natural History Brit. Butterflies*.

44. **1917, Sept. 17. Kirkheaton Tip, nr. Huddersfield, Yorks.**
One caught by C. Cameron (B. Morley, *Naturalist* **1928** : 47). In Huddersfield Museum.

TABLE 18 (*Continued*).

45. **1917, Oct. 1. Instow, Devon.**
One seen by G. F. Mathew (*Entomologist* **54** : 211).

46. **1918, Aug. 19. Porthcurno, Cornwall.**
One female caught by M. L. Wandle (J. G. Wandle, 21.ix.1918, *The Field* **132** : 263; see also F. W. Frohawk, *Entomologist* **51** : 256).

47–48. **1920, —. Tilbury, Essex.**
Two specimens said by F. W. Buxton, purser of a steamer, to have come over on the boat from Norfolk, Virginia, and to have flown away on reaching Tilbury (F. W. Frohawk, *Entomologist* **54** : 145).

49. **1923, Aug. 28. Selmeston, nr. Berwick, Sussex.**
One male captured, ? by J. C. Tunnard (20.ix.1923, *The Field* **142** : 427). Seen by F. W. Frohawk (*Entomologist* **56** : 258).

50–51. **1923, Sept. Portslade, Sussex.**
One caught and one seen by Mrs. Brown and given to A. H. Griffith (Griffith, *Entomologist* **58** : 97). Now in Nat. Mus. Wales at Cardiff.

52. **1926, Sept. Cockerton, nr. Darlington, Durham.**
One captured, ? by E. O. D. Sibson (*Entomologist* **60** : 82). Now in Darlington Museum.

53. **1926, Sept. Headlington Hill, Oxford.**
One seen almost daily for a fortnight by E. W. Gordon (L. Dawes, *Ent. mon. Mag.* **64** : 90).

54. **1926, Sept. 8. Nr. Countisbury, Devon.**
One seen by S. Morris (C. Nicholson, *Entomologist* **71** : 220).

55. **1928, Sept. 5. Llanmadoc, Gower, Glamorgan.**
One seen by H. E. David (*Entomologist* **61** : 250).

56. **1929, Aug. 12. Kimmeridge, Dorset.**
One believed to have been seen by H. L. Andrewes (*Entomologist* **63** : 67): identification not very certain.

57. **1929, Oct. 12. Niton, Isle of Wight.**
One seen by R. Prendergast (16.x.28, *Times*; see also *Ent. mon Mag.* **65** : 261).

58. **1930. Ruan Minor, Cornwall.**
One seen by A. L. Crossman (26.x.33, *Western Morning News*; see Nicholson, *Entomologist* **68** : 248).

—. **[1930, Aug. ?20. Upper Clapton, N.E. London.**
According to C. W. V. Gane a small boy captured two Monarchs which were taken to the Natural History Museum and identified by N. D. Riley as the Indian Monarch *Danaus genutiae* (C. Nicholson, *Entomologist* **71** : 218).]

59. **1931, June? Framlingham, Suffolk.**
One seen by C. H. S. Vinter (1933, *Trans. Suffolk N.H. Soc.* **2** : 104).

60. **1931, Oct. 3. Modbury, Devon.**
One seen by H. E. Hooppell (8.v.1933, *Western Morning News*; see also C. Nicholson, *Entomologist* **68** : 248).

61–64. **1932, end Aug. and Sept. Tresco Abbey, Scillies.**
Two seen by a clerk at end August, one seen by a " man " and another by A. A. D. Smith in September (Smith, 1933, *Entomologist* **66** : 6).

65. **1932, Sept. 15. Llanbadarn Fawr, nr. Aberystwyth, Cardigan.**
One seen by J. H. Saltern (1932, *N. West. Naturalist* **7** : 315).

66. **1932, Sept. 16. Burton Bradstock, nr. Bridport, Dorset.**
One seen by K. Trenchard Cox (1.x.1932, *Times*; see also Williams, 1933a : 7).

67. **1932, Sept. 20? Fossebridge, Gloucester.**
One seen by C. F. Parks (C. Nicholson, *Entomologist* **71** : 220).

68. **1932 (Sept. 21). Bognor, Sussex.**
One seen by E. H. Hewett (5.x.1932, *Times*; also *Ent. Rec.* **45** : 45). Date not in original.

69. **1932, Sept. 26. New Milton, Hants.**
One caught by Mr. Sturmey (F. W. Frohawk, *Entomologist* **66** : 27). Now in coll. of Sir B. Whitehouse of Birmingham.

70. **1932, Oct. 1. Abbotsbury, Dorset.**
One seen by E. H. Smyth (*Entomologist* **65** : 284).

71. **1932, Oct. (20). Porthcurno, Cornwall.**
One caught by A. J. Gardiner (C. Bartlett, *Entomologist* **67** : 248). Now in collection of A. J. Gardiner.

72. **1932, Oct. 22. Corbally, Limerick, Ireland.**
One seen by N. H. Wilson (C. Nicholson, *Entomologist* **68** : 249).

TABLE 18 (*Continued*).

73. **1933, June 14–18. Nelson, Lancs.**
One seen by J. Wensley, verified by W. G. Clutter (T. Dannreuther, *Entomologist* **67** : 11).

74. **1933, July 4 or 5. Corfe Castle, Dorset.**
One seen by D. C. Thomas (T. Dannreuther, *Entomologist* **67** : 209).

75–79. **1933, July 14. Off Seacombe Cliffs, Dorset.**
Five seen three miles out at sea by Mr. Bower (F. W. Frohawk, *Entomologist* **66** : 250).

80. **1933, Aug. 11. Nr. Ditchling Beacon, Sussex.**
One seen by G. T. St. J. Steadman (C. Nicholson, *Entomologist* **71** : 220).

81. **1933, Aug. 16. Off Seacombe Cliffs, Dorset.**
One seen about 3½ miles out at sea by Mr. Bower (F. W. Frohawk, *Entomologist* **66** : 250).

82. **1933, Sept. Off Margam, Glamorgan.**
One seen by H. David (C. Nicholson, *Entomologist* **68** : 249).

83. **1933, Sept. Hawthorne Dene, Durham.**
One captured by a student [Miss Farmer]. Seen by J. D. H. Harrison (T. Dannreuther, *Entomologist* **67** : 164.) [Specimen now destroyed. C.B.W.]

—. [1933, Sept. 2. Bude, N. Cornwall.
See under Sept. 12, which is correct date.]

84. **1933, Sept. 2. Lelant, Cornwall.**
One male caught by Miss Briant (F. W. Frohawk, *Entomologist* **67** : 134). Now in collection of Sir B. Whitehouse of Birmingham.

85. **1933, Sept. 3. Salcey Forest, Northants.**
One seen by R. D. Pendered (T. Dannreuther, *Entomologist* **67** : 164).

86. **1933, Sept. 4–6. Howth Promontory, Dublin.**
One seen by G. Hemphill (1933, *Irish Nat.* : 244; see also T. Dannreuther, *Entomologist* **66** : 254).

87. **1933, Sept. 5. Budleigh Salterton, Devon.**
One caught by M. Wood (6.x.1933, *Times*; see also F. W. Frohawk, *Entomologist* **66** : 250). Now in collection of Mrs. M. Wood of Westbury, Wilts.

88. **1933, Sept. 9. Penhale Pt., Cornwall.**
One seen by D. O. Boyd (*Entomologist* **66** : 234).

89. **1933, Sept. 10. Battle, Sussex.**
One seen by Mrs. Arnold (28.vii.1934, *Times*; see T. Dannreuther, *Entomologist* **67** : 209).

90. **1933, Sept. 12. Bude, Cornwall.**
One captured by B. J. Leader (*Entomologist* **66** : 225), date given as Sept. 2 in original by mistake.

91. **1933, Sept. 18. Bexhill, Sussex.**
One seen by K. Jackson (T. Dannreuther, *Entomologist* **66** : 254).

92. **1933, Sept. 19. Boreham Street, Sussex.**
One seen by K. Jackson (T. Dannreuther, *Entomologist* **66** : 254), possibly the same individual as the previous record.

93. **1933, Sept. (20). Church Cove, Lizard, Cornwall.**
One seen by P. H. Dean (T. Dannreuther, *Entomologist* **66** : 254).

94. **1933, Sept. 20. Lymington, Hants.**
One seen by J. Nickell (T. Dannreuther, *Entomologist* **66** : 254).

95. **1933, Sept. 21. Tenby, Pembrokeshire.**
One female caught by H. Mathias (T. Dannreuther, *Entomologist* **66** : 254). Now in National Collection at Tring. Typical N. American form.

96. **1933, Sept. 21. Bognor, Sussex.**
One seen by R. J. Hodgson (4.x.1933, *Times*; see T. Dannreuther, *Entomologist* **66** : 254).

97. **1933, Sept. 26. Eastbourne, Sussex.**
One female caught by a schoolboy (R. Adkin, *Entomologist* **66** : 250).

98. **1933, Sept. 26. Little Common, Bexhill, Sussex.**
One seen by H. G. McLeod (*Entomologist* **69** : 42; see also T. Dannreuther, *Entomologist* **66** : 254). Seen from only a few feet away.

99. **1933, Sept. 26. Bexhill, Sussex.**
One seen by W. A. Elder (T. Dannreuther, *Entomologist* **66** : 254). Possibly the same individual as the previous record.

100. **1933, Sept. 27. West Cove, near Cahirdaniel, Co. Kerry, Ireland.**
One male caught by M. M. Green (S. Kemp, *Entomologist* **66** : 241).

TABLE 18 (*Continued*).

101. **1933, Sept. 27. Housel Bay, Lizard, Cornwall.**
One seen by P. H. Dean (T. Dannreuther, *Entomologist* **66** : 254).

102. **1933, Sept. 29. Housel Bay, Lizard, Cornwall.**
One seen by P. H. Dean (T. Dannreuther, *Entomologist* **66** : 254), possibly the same as the previous record.

103. **1933, Sept. 30. Mawnan Smith, Cornwall.**
One seen by R. B. Goodden (T. Dannreuther, *Entomologist* **67** : 209).

104. **1933, Oct. 1. St. Mawes, Cornwall.**
One captured by W. C. May (14.x.1933, *Western Morning News*; C. Nicholson, *Ent. Rec.* **46** : 20). Now in collection W. E. May.

105. **1933, Oct. 1. Exmouth, Devon.**
One seen by S. D. Gibbard (3.x.1933, *Western Morning News*; also T. Dannreuther, *Entomologist* **66** : 254).

106. **1933, Oct. 2. Hastings, Sussex.**
One seen by A. M. Elliott (*Entomologist* **66** : 279), inspected closely for several minutes and said to be a male as scent spots on hind-wing were noticed (*Entomologist* **67** : 11).

107. **1933, Oct. 12. Blagdon, Somerset.**
One seen by G. S. Griggs (T. Dannreuther, *Entomologist* **66** : 254).

108. **1933, Oct. 15. Ruan Minor, Cornwall.**
One seen by A. L. Crossman (T. Dannreuther, *Entomologist* **67** : 12).

109. **1933, Oct. 29. Nr. St. Ives, Cornwall.**
One male captured by F. A. Turk.

110. **(1933). Lanarth, St. Keverne, Cornwall.**
One seen by Lady Seaton (C. Nicholson, *Entomologist* **71** : 218).

111. **1934, July 15. Ringwold, Kent.**
One seen by H. C. Gunton (1.viii.1934, *Times*; also T. Dannreuther, *Entomologist* **67** : 213).

112–113. **1934, Aug., 2nd week. Off Beer Regis, Devon.**
Two seen by Miss Mercer (C. Nicholson, *Entomologist* **71** : 220).

114. **1934, Aug. 25. Oxford.**
One seen by B. M. Hobby (C. Nicholson, *Entomologist* **71** : 220). Large butterfly, identification not quite certain.

115. **1934, Aug. 29. Dudbridge, nr. Stroud, Gloucester.**
One seen by Miss Wright (C. Nicholson, *Entomologist* **71** : 217).

116. **1934, Sept. 19. Denham, Bucks.**
One seen by G. B. Oliver (*Entomologist* **67** : 248).

117. **1934, Sept. 20. Coombe Martin, Devon.**
One seen by Mrs. Miall (F. W. Frohawk, *Entomologist* **67** : 248).

118. **1934, Sept. 25. Minehead, Somerset.**
One caught by — Bentley, Jr. (R. C. Bentley, *Entomologist* **67** : 248). Now in collection of R. C. Bentley.

119. **1934, Sept. 27. Bideford, Devon.**
One seen by W. M. Littlewood (3.x.1934, *Times*; see also F. W. Frohawk, *Entomologist* **67** : 248). Said to be a female but not captured.

120. **1934, Sept. 27. Northiam, Sussex.**
One female seen by A. Townsend (T. Dannreuther, *Entomologist* **68** : 136).

121. **1934, Oct. 2. Bolton Abbey, Yorks.**
One caught by a farm boy (F. G. Britton, *Entomologist* **67** : 248). Now in collection of F. G. Britton.

122. **1934, Oct. 5. Milford Haven, Pembroke.**
One seen by A. V. W. Stokes (20.x.1934, *Field* **164** : 930; also T. Dannreuther, *Entomologist* **68** : 8).

123. **1934, Oct. 11. Lymington, Hants.**
One seen by P. E. G. Harding (20.x.1934, *Field* **164** : 930; also T. Dannreuther, *Entomologist* **68** : 8).

124. **1934, Oct. 22. Dunster, Somerset.**
One caught ? by R. C. Bentley (*Entomologist* **67** : 248). Now in collection of R. C. Bentley.

125. **1935, March 21. Brighton, Sussex.**
One seen by J. Brazenor (T. Dannreuther, *Entomologist* **68** : 109).

126. **1935, April 21. Lulworth Cove, Dorset.**
One seen by a lady (H. G. Harris, *Entomologist* **68** : 136).

TABLE 18 (*Continued*).

127. **1935, July 17. Ashley, New Milton, Hants.**
One seen by L. F. Burt (W. P. Curtis, *J. Soc. Brit. Ent.* **1** (5) : 121).

128. **1935, early Sept. Aberystwyth, Cardigan.**
Seen coming in from sea. Captured but escaped again. A. G. Walker (Williams, *Entomologist* **73** : 173).

129. **1935, Sept. 25. Coverack, Cornwall.**
One seen by A. T. Cummings (F. Pennington, *Entomologist* **69** : 94).

130. **1935, Sept. —. Bourton-on-the-Water, Gloucester.**
One seen by Miss Donovan (C. Nicholson, *Entomologist* **71** : 217).

131. **1935, Oct. 4. South Huish, Devon.**
One caught by Mr. Halahan and given to Mr. J. O. N. Wood (Wood, *Entomologist* **69** : 230). Now in collection of J. O. N. Wood.

132. **1935, Oct. 13. Penally, Pembroke.**
One caught by G. Scott-Brown (23.xi.1935, *Field* **166** : 1242 ; see also T. Dannreuther, *Entomologist* **69** : 5).

133. **1936, Aug. 8. Sowley, Lymington, Hants.**
One seen by Mr. Harding (22.viii.1936, *Field* **168** : 464 ; see also T. Dannreuther, *Entomologist* **69** : 226).

134. **1936, Aug. 11. Start Point, Devon.**
One seen by A. W. Godfrey (T. Dannreuther, *Entomologist* **69** : 226).

135. **1936, Aug. 18. Meonstoke, Petersfield, Hants.**
One seen by Mr. Rawlins (T. Dannreuther, *Entomologist* **69** : 259; and C. Nicholson, *Entomologist* **71** : 221).

136. **1936, Aug. 22. Burley, Hants.**
One seen by F. H. Hargreaves (12.xi.1936, *Field* **168** : 630 ; also T. Dannreuther, *Entomologist* **69** : 226).

137. **1936, Aug. 25. West Meon, Hants.**
One seen by G. B. Wood (12.ix.1936, *Field* **168** : 620; also T. Dannreuther, *Entomologist* **69** : 226).

138. **1936, Sept. 4. Leanwater, Lizard, Cornwall.**
One seen by H. C. Griffith (18.ix.1936, *Western Morning News*; also T. Dannreuther, *Entomologist* **70** : 8).

139. **1936, Sept. 8. Oakhanger Pond, Selborne, Hants.**
One caught by I. P. Russell (T. Dannreuther, *Entomologist* **70** : 8).

140. **1936, Sept. 16. Salcombe, Devon.**
One seen by Mrs. Besant (22.ix.1936, *Western Morning News*; also T. Dannreuther, *Entomologist* **69** : 259).

141. **1937, Aug. 6. Rushmore Hall, Ipswich, Suffolk.**
One caught by Miss R. M. King (1937, *Trans. Suffolk N.H. Soc.* **11** : 104).

142. **1937, Sept. 8. Selsey Bill, Sussex.**
One female caught by T. Trought (*Entomologist* **70** : 285). Now in collection of T. Trought.

143. **1937, Sept. 28. Slapton, S. Devon.**
One seen by H. O. Mills (T. Dannreuther, *Entomologist* **70** : 253). Identification not very certain.

144. **1937, Sept. 28. Stoke Fleming, Devon.**
One seen by H. M. Churchward (T. Dannreuther, *Entomologist* **70** : 253).

145. **1937, Oct. 2. Harrow, Middlesex.**
One seen by K. Clarke (E. W. Classey, *Entomologist* **70** : 246).

146. **1937, Oct. 2. Lydney, Gloucester.**
One male caught by H. Angel (C. G. Clutterbuck, *Entomologist* **70** : 249). Now in Gloucester Museum.

147. **1938, Aug. 15. Porth Conger, St. Agnes, Scillies.**
One seen by E. B. King (*Entomologist* **71** : 236).

148. **1938, Aug. late. Fernhurst, Sussex.**
One seen by Dr. B. Barnes (*in litt.*).

149. **1940, Nov. 4. Putsborough, N. Devon.**
One female captured by W. R. C. Mathews and kept alive for two weeks (C. W. Bracken, *Entomologist* **74** : 42).

150. **1941, Aug. 30. Kynance, Lizard, S. Cornwall.**
One female captured 6.20 p.m. in perfect condition by E. B. Ford (*Entomologist* **74** : 220).

151. **1941, Sept. 14. Sandsting, W. Shetland.**
One captured by G. Johnston.

in fig. 23, from which it will be seen that the earliest peak years were 1876, 1885–6, 1896, and then a quite unusual series of captures from 1932–1937 with a peak of 38 records for 1933. Part of the numbers of this last peak must, however, be put down to the greatly increased interest taken in the problem of immigration.

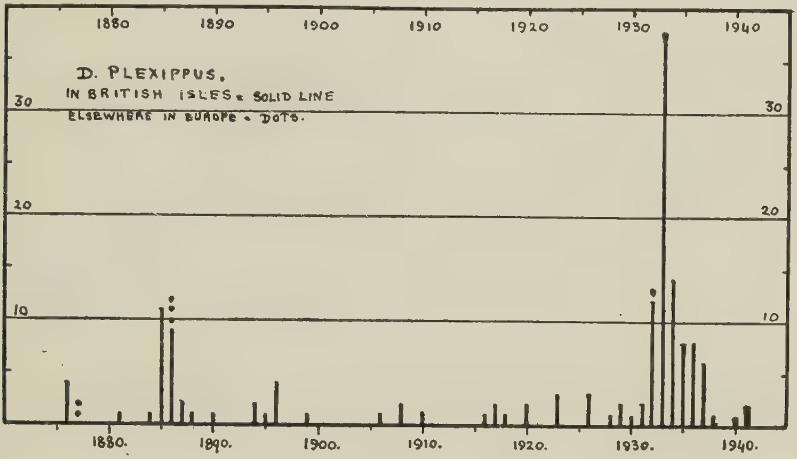

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FIG. 23.—Diagram of the annual records of *D. plexippus* in the British Isles since 1876.

Fig. 24 shows the distribution throughout the year of the British records in half-monthly periods. Only three specimens (one each in March, April and May) have been recorded before the end of June: none of these were captured. After that there are records to the beginning of November with a very definite peak in the second half of September.

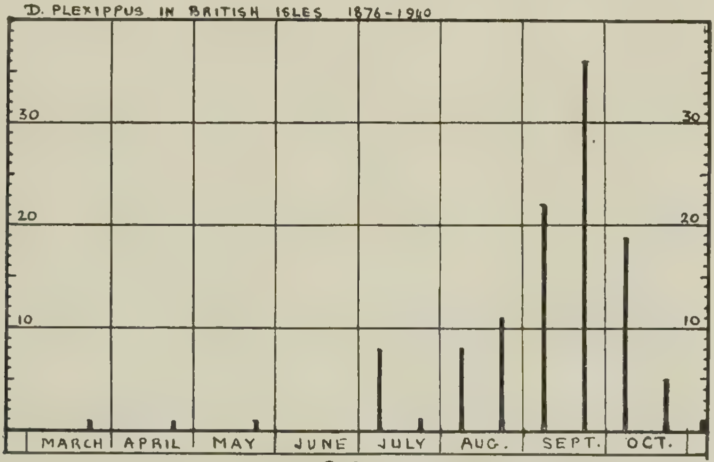

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FIG. 24.—Records of *D. plexippus* in the British Isles arranged according to the date of observation.

The proportion of sexes in the captures is as follows:—Males: 9 captured + 1 only seen; females: 18 captured + 2 only seen. The sex of the specimens which were only seen is of course open to doubt. Efforts have been made to trace and examine, or to have examined, as many as possible of the British-caught individuals. The results are shown in Table 19.

Table 19.

Present location and geographical race of specimens of *D. plexippus* captured in the British Isles.

1 (1) 1876, Sept. 6, at Neath. Now in British Museum, seen by C. B. Williams; typical N. American female.

9 (2) 1885, Sept. 17, Lizard. Now in Truro Museum, Devon (see below).

12–13 (3)–(4) 1885, Sept. 24, Housel Bay. Now in Truro Museum.

The three specimens above were examined in October 1940 by Mr. F. A. Turk, who reports that they are together in a case which states that all three were taken on 17th September, 1885. All three are females. Two are typical North American type and the third " definitely approaching the Central American form having the spots perfectly white and only two slight traces of the red brown areas in the black tip of the fore wing."

18 (5) 1886, Aug. 14, Lyme Regis. Now in Hope Department, Oxford, seen by C. B. Williams; typical N. American female, but faded and spots very pale.

22 (6) 1886, Sept., Glanafon. Said in 1914 to be in Nat. Museum of Wales at Cardiff, not possible to verify at present owing to collections being stored for protection.

26 (7) 1886, " Cornwall." Said in 1914 to be in " Vivien collection," Nat. Mus. Wales, Cardiff (see no. 6).

42 (8) 1910, Oxford. Now in Hope Department, Oxford, seen by C. B. Williams; almost typical N. American male perhaps slightly less brown in outer portion of wing.

43 (9) 1916, Co. Cork. Now in collection of F. W. Frohawk, figured by Frohawk as typical N. American female.

44 (10) 1917, Sept., Kirkheaton. In Huddersfield Museum. Examined in Sept. 1940 by Mr. W. Anbrook, who reports it to be a typical N. American male.

50 (11) 1923, Sept., Portslade. In Nat. Mus. Wales, Cardiff, seen by G. F. Cockbill; typical N. American, spots buff.

52 (12) 1926, Sept., Darlington. Now in Darlington Town Museum. Examined carefully by Mr. J. E. Nowers in March 1940, who reports it as a typical N. American male.

69 (13) 1932, Sept. 26, New Milton. In 1939 in collection of Sir Beckwith Whitehouse. Examined by him in 1939 and reported to be a typical N. American female.

71 (14) 1932, Oct. 20, Porthcurno. In 1939 in collection of Mr. A. J. Gardiner.

84 (15) 1933, Sept. 2, Lelant, Cornwall. In 1939 in collection of Sir Beckwith Whitehouse, who reports " typical N. American male."

87 (16) 1933, Sept. 5, Salterton. In collection of Mrs. M. Wood, The Garth, Westbury, Wilts., who examined it in July 1940 and reports that it is a female somewhat intermediate between the N. and C. American forms. The spots are white with buff areas present. Possibly the spots are faded.

90 (17) 1933, Sept. 12. Bude, Cornwall. Now in collection of Mr. C. W. Whitworth-Hulse, who examined it in August 1941 and reports that it is a female of the typical North American form, with buff spots on the fore-wing.

95 (18) 1933, Sept. 21, Tenby. Now at Tring. Seen in 1939 by C. B. Williams. Typical N. American female.

104 (19) 1933, Oct. 1, St. Mawes. Now in collection of W. C. May, Council School, St. Mawes.

109 (20) 1933, Oct. 29, nr. St. Ives, Cornwall. In Sept. 1940 in collection of Mr. F. A. Turk, who reports that it is a typical N. American male. Since presented to National Collection at Tring.

118 (21) 1934, Sept. 25, Minehead. In 1939 in collection of R. C. Bentley, Minehead.

121 (22) 1934, Oct. 2, Bolton Abbey. In 1939 in collection of Rev. F. G. Britton, Springfield Manse, Addington, Ilkley, who examined it in July 1940 and reports " typical North American female."

TABLE 19 (*Continued*).

124 (23) 1934, Oct. 22, Dunster. In 1939 in collection of R. C. Bentley, Minehead.
131 (24) 1935, Oct. 4, South Huish, Devon. In 1939 in collection of J. O. N. Wood, 144 Tulse Hill, London, S.W. 2.
132 (25) 1935, Oct. 13, Penally, Pembroke. Said to be in collection of Mr. A. N. Winnell, Lydstep House, Penally, but I cannot trace Mr. Winnell at this address.
142 (26) 1937, Sept. 8, Selsey. In 1939 in collection of T. Trought, who examined it and reports a female of typical N. American form.
146 (27) 1937, Oct. 2, Lydney, Glos. In Gloucester Museum. Examined in July 1940 by the curator Mr. C. Green, who reports it to be a typical N. American male.
149 (28) 1940, Nov. 2. Putsborough, N. Devon. In National Museum at Tring. Typical N. American female.
150 (29) 1941, Aug. 30, Kynance, Cornwall. In September 1941 in collection of E. B. Ford, who reports that it is a typical N. American female.
151 (30) 1941, Sept. 14. Shetland. Presented to R. Scottish Museum, Edinburgh. Examined by G. R. Waterston, who reports it to be a female of N. American type.

In addition to the above two further specimens have been followed up but are now known to have been destroyed. These are :—

1933, Sept., Hawthorndene, Durham.
1936, Sept., Selborne, Hants.

Thirty specimens have been located and of 22 examined all except one are of the typical North American type. The exception is one caught by A. H. Jenkin in 1885, and now in the Truro Museum, which is reported on examination by Mr. Turk to be definitely approaching the Central American form, having the spots perfectly white and only two slight traces of the red-brown areas in the black tip of the front wing.

Table 20 gives all the records traced of the appearance of *D. plexippus* in the Continent of Europe. Excluding the very doubtful records, they are :—2 in France, 4 in Spain and Portugal, and 1 in Holland. In addition there is the unique record of several specimens captured on a steamer outward bound from Glasgow, about 1880, when about 200–300 miles from the British shores. This record is the most definite piece of evidence in support of the idea that the insects fly across the Atlantic, but unfortunately there is no exact date and the specimens cannot now be traced.

TABLE 20.

D. plexippus captured or seen in the European area, excluding the British Isles.

[1842, Sept. Schloss Seehof, Bavaria.
A drawing of a Monarch butterfly was found with this date and locality (Forman, 1927, *Entomologist* **60** : 103). It is very doubtful evidence.]

1877, Sept., early. La Vendée, W. France.
One captured early in September and a second seen about 8 days later by M. Grassal (Baret, *Pet. Nouv. Ent.* **2** : 253–4).

1880 (about). Atlantic, Off N. Ireland.
Several specimens of the N. American type given to Mr. J. F. X. King by an officer of a steamer outward bound from Glasgow. Butterflies caught playing round rigging about 200–300 miles from British shores., (C. G. Barratt, 1893, *Ent. mon. Mag.* **29** : 163). Enquiries were made in 1937, but no specimens could be found in J. F. X. King collection now at Glasgow University.

1886, Oct. The Hague, Holland.
One captured by J. E. Muschait (Snellen, 1887, *Tijdsch. v. Ent.* **30** : c–ci). G. A. Bentinck (1937, *Ent. Berich.* **9** : 258) says caught in a greenhouse. Specimen now lost.

1886, Oct. 29. Gibraltar.
One male of average size and N. American type captured by Lt. Comm. Cochran and seen by J. J. Walker two days later (Walker, 1886, *Ent. mon. Mag.* **23** : 162).

TABLE 20 (*Continued*).

1886, Sept. 29. Oporto, Portugal.
One female caught by G. D. Tait in his garden (H. Goss, 1887, *Entomologist* **20** : 106).

Some years before 1893. Off Cape St. Vincent, Portugal.
One caught at sea 60 miles from Cape St. Vincent, " some years ago." Then in coll. of G. A. Harker (1893, *Ent. mon. Mag.* **29** : 86).

1897, Nov. 8. Grecian Archipelago.
G. Mathew (1903, *Ent. Rec.* **15** : 162) says that a *D. plexippus* " flapped slowly over the steamer." (I feel sure that this is a misidentification for *D. chrysippus.* C.B.W.)

1932, Oct. 2. Near Oporto, Portugal.
One captured by Mr. Stock and given to Mr. M. A. de Silva Cruz. Another said to have been seen about the same time a little to the north. (Letter to T. Dannreuther from J. T. Wattison, Dec. 16, 1935.)

It does not seem possible at present to reach a final decision as to whether the British records relate to individuals which have flown across or have been brought across in the holds of ships. It is quite possible that both explanations may be true. The subject has been discussed recently by Nicholson (1935 and 1938). He inclines to the idea that they have all been brought over in ships, but the record just quoted seems impossible to fit into this theory.

(2) *Phoebis eubule* L. (= *Catopsilia sennae*).

In 1938 I published a brief summary (Williams 1938b) of the information available relating to the migrations of this butterfly in the United States. Since then a number of new records have come in relating to this country, including the continuous observations made by Mr. and Mrs. Hodges in Florida already discussed on p. 151. There are also several records for Central America and the West Indies which have not yet been published.

Records relating to flights in the U.S.A.

Alabama. The eighteen years' observations by Mr. P. Smyth which were discussed in my last summary (Williams 1938b) have been also referred to very briefly by Mr. Smyth in a short note (Smyth 1938).

The regularity of movements in this State is confirmed by Mr. J. S. Mason, from Montgomery, who writes : " For many years since 1882 I have noticed the migration of yellow butterflies. In the autumn months they appear in numbers flying to the south-east. They fly in a leisurely manner." Mr. W. A. Ruffin has also observed flights " in a southerly direction."

Arkansas. Mr. A. M. Merrill of Rogers, Ark., writes that the butterflies congregate there in great numbers all at once and " As their wings are not worn I believe they migrate here and stop on their way south. It is almost impossible to find larvae here during the summer."

Mr. Easton saw a large flight to the east in September and October 1933 which is described more fully below under " Louisiana."

New Mexico. Mr. P. R. Gleason writes from Denning, N. Mexico, that the species is rare there but that he saw a few during July and August 1939, becoming more frequent in early September. One pair was seen mating on the 8th September but by the end of the month all had gone. In 1940 the first reappearance was on the 18th March, when two were seen flying steadily to the east.

Florida. In addition to the observations of Mr. and Mrs. Hodges (see p. 151), Mr. W. F. Smith writes that the butterfly occurred commonly at Englewood during December 1937. Twenty were seen on the 30th December, but it became gradually rarer until only two were noted in the last two weeks of March.

Mr. T. K. Cooper states that, at Cape St. George Island, in the north-west of Florida, in 1937 only very few were seen before the end of October but that it then became fairly numerous.

Georgia. Mr. P. M. Gilmer writes (November 1937), " The movement here [Tifton], while somewhat more southerly than in Louisiana, is still distinctly easterly. Tifton is 130 miles from the coast and 60 miles from the Florida line so the movement should be south rather than east if the insects were turning south into Florida. I believe, however, it is rather easterly than southerly even here, although close to S.E. A S.E. movement from here would strike the Atlantic coast only a few miles south of Jacksonville, which is only about 50 miles south of the border. I have only one observation near the coast, in late August 1937, when I saw two specimens flying S.E. disappear out to sea at Sea Island Beach, Brunswick, Ga. They were flying steadily 4–5 feet above the water. From this I am inclined to believe that the movement does not turn south but continues to the S.E. until the death of the insects either by drowning at sea or by natural causes inland." (See below for records of flights out at sea in the Bahama Islands.)

Mr. L. Harris writes that in September 1926, at Decatur and Atlanta, Georgia (both well inland), he saw a movement to the S.E. for several days. Not more than one or two were in sight at one time, usually 2–6 feet from the ground, rising over obstacles and immediately descending to the ground again.

Iowa. Mr. C. W. Thorwald sent three specimens from Chariton, Iowa, in October 1937, with the information that they had appeared within the past three months but were not common in Iowa.

Louisiana. Mr. H. D. Easton writes that in September and October 1933 he observed a very distinct migration of *P. eubule* flying to the East or E.S.E. in Louisiana and Arkansas. The migration was most dense from 15th September to 15th October and then thinner. It was observed from Noel, just over the border from Arkansas into Missouri, to Alexandria and De Ridder in Southern Louisiana, over a front of approximately 400 miles. He estimates the number of butterflies in the flight as " billions."

Again in the autumn of 1937 Mr. Easton noted a very much thinner flight in exactly the same direction over a large part of the State of Louisiana.

Mr. P. Glick writes that he saw movements of *P. eubule* to the east in the autumn almost every year that he was at Tallulah, La. The flights lasted for about three weeks and the insects flew all day singly rather than in groups.

Mr. P. M. Gillmer, who also lived at Tallulah, La., says that the flights often reached a density of one insect per 100 feet. They flew individually near the ground, rarely higher than 3–6 feet. In crossing a depression at Tallulah about 30 feet deep and 50–100 yards wide they went down to the bottom and not straight across. The general direction was a little E. of S.E.

Mississippi. Mr. R. S. Smith reports, in continuation of records already published (Williams 1938b), that in 1937 the flight to the east at Biloxi Bay was first distinct on 4th July, and not 1st July as previously stated. The air was filled with butterflies.

In 1938 the flight started about 14th August and was almost at its end on 13th October. It was in the usual direction and of normal numbers.

Mr. C. Lyle reports that about 1923 at the end of October or beginning of November he saw large numbers of *P. eubule* flying to the east at Bay St. Louis, Miss.

Missouri. Shannon (1935, map p. 157) indicates an annual flight to the south at Independence, near Kansas City, Missouri.

North Carolina. Mr. R. M. Dayton reports that he saw a definite movement of *P. eubule* to the south at Carolina Beach, near Wilmington, North Carolina, at the beginning of October 1935. The weather was hot, many days about 90° F. " While the Monarchs drifted round and stopped here and there, the ' Cloudless Sulphurs ' went right through, flying strong and fresh usually about 10 feet up." They were very difficult to catch but he managed to get two. Usually two or three were always visible at one time. The flight lasted through October to the beginning of November.

Tennessee. Mr. C. McR. Plummer has made observations on the movements of *P. eubule* in the neighbourhood of Bolivar, Tenn., in three successive years.

In September 1937 he noted, while driving between Bolivar and Nashville, several individuals all going to the S.E. which was " the usual direction."

In 1938 the flight was observed from August 18th until the end of the month and continued in September. In August about 40 per hour were seen, all flying to the S.E. about six feet above the ground or any obstacle in their path. He writes, " On one occasion we noticed a butterfly stray from the path of its predecessors and go into the woods, but it came out again a few hundred feet farther on and resumed flight along the regular path. We were amazed when the next butterfly exactly duplicated this performance though it was not in sight of the former. The next one which came along, however, resumed the direct path of the normal migration."

Mr. Plummer also writes, " I have noticed that when we have a cold snap, the numbers of the insects are almost doubled. The Sulphurs are flying today (24th September 1938) at about 70 per hour which is compared with the 40 per hour of the warm August days. Today is not frosty, but cool enough for a jacket." And again, " The wind seems to have no effect on the numbers, and little effect on the speed of the flight. When the wind is favourable, *i.e.*, tail-wind, the insects seem to fly with less deviation and less ' fluttering,' but my pure guesswork doesn't indicate that they move much faster than when the wind is across or opposite to the direction of flight."

In 1939 Mr. Plummer reported that the flight began very early and before the end of June a few individuals had been seen moving fast to the E.N.E.

Texas. Mr. B. Struck writes that he has noticed a southerly movement of this species, together with *P. agarithe*, in the fall in the district round San Antonio Bay and Corpus Christi, Texas.

Mr. R. J. Watson observed a flight from 8th to 10th August 1941 in Rusk County, E. Texas, flying about 4 miles per hour about 6 feet above the ground. The width of the territory observed was about 24 miles. About 500 per hour were passing within sight between 11 a.m. and noon. The wind was very light from S.W. Temperature 95° F. Flight from west to east.

America (*outside U.S.A.*).

Mexico. Dr. C. W. Sabrosky informs me that on 3rd August 1933 he saw numbers of *P. eubule* flying to the south at Guerrerio, State of San Luiz Potosi, Mexico, about 60 miles west of Tampico.

Guatemala. According to Mr. A. F. Novella, this species emigrates southward from Mexico into Guatemala in August, arriving about the middle of the month.

Mr. M. Y. Fuentes reports a large flight, 800 metres wide, 4 kilometres long and 2–12 metres above the ground, in the first week in August 1938 at Ocos, Guatemala towards the S.E. This locality is on the Pacific coast near the Mexican border.

Panama. Miss C. Longfield has recorded (Poulton 1932a) a flight of this species at Colon, Panama, on 9th June 1924, when hundreds were flying to the S.W.

Jamaica and at sea south of Jamaica. Dr. E. Murray-Aaron informs me that in the autumn of 1889 he saw a flight of scattered groups of this butterfly going almost directly south at about 6000 feet elevation in the Upper Garden, Blue Mountains, Jamaica. A few days later Captain Morris of S.S. *Ailsa* reported that he had seen them for at least two days "well over" the Caribbean Sea and heading towards Venezuela.

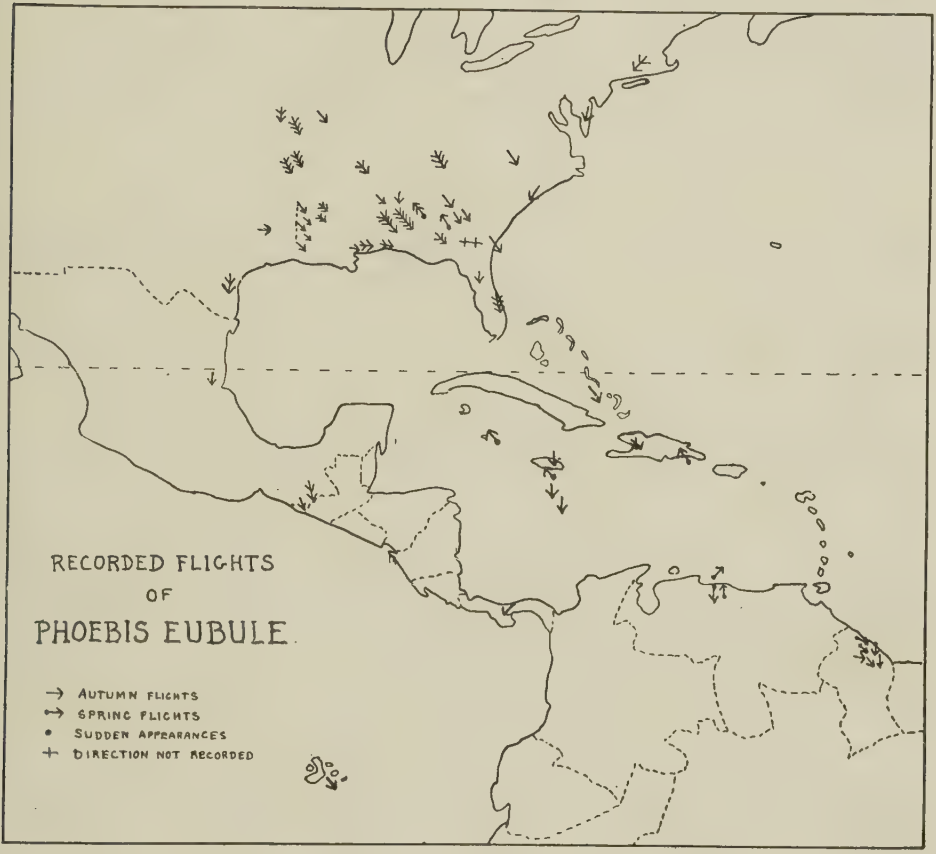

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FIG. 25.—Recorded flights of *Phoebis eubule* in North and South America and the West Indies.

Haiti. Mrs. B. C. Scott informs me that in June 1920 there was a flight for at least one hour towards the S.E. near Port au Prince, Haiti; and on several subsequent occasions she has seen similar flights in the same direction. The butterflies are locally known as "Papillon St. Jean" and their wanderings have become the subject of a native song (see p. 104).

Caribbean Sea. Dr. E. Murray-Aaron sends me the two following accounts of flights of *C. eubule* in the Caribbean Sea. It is curious that there are no more recent records.

(*a*) In 1891 Mr. F. Herzog, an entomologist from Frankfort-on-Main, returning from Panama, showed him specimens of *C. eubule* which were part of large numbers seen flying to the south over the sea about 100 miles south of Jamaica. Some of them had settled on the ship's deck. The captain of the steamer had told Mr. Herzog that this was a common thing "about hurricane time." This is about mid-August to mid-October in these waters.

(*b*) Dr. Aaron gives in a boys' story-book a popular account (Murray-Aaron 1894) of a flight of *C. eubule* over the sea in the neighbourhood of the Bahamas. He tells me that this account is substantially correct. The flight was observed on 12th or 13th October 1889, moving towards the south-east at the north end of Fortune Island Passage in the Bahamas off the east shore of Rum Cay. Many hundreds of butterflies were in sight at one time flying in parallel columns. They were seen at daybreak and had been noted passing over Watlings Island on the previous day.

The map (fig. 25) shows all the known information on the distribution of the flights of *P. eubule.* By far the most striking feature is the south-easterly movement in the autumn in the south-eastern part of the U.S.A., which seems to extend to some of the Northern West Indian Islands and possibly over the Caribbean Sea.

There are north-westerly flights in the spring recorded in Haiti, Jamaica, the Cayman Islands and in Alabama.

The most important records that do not fit into the scheme are the observations of Mr. and Mrs. Hodges in Florida (see p. 151), who noted southerly flights throughout the whole year.

(3) *Eunica monima* (Cramer).

In my summary (Williams 1930b) only one record of the migration of this species was available in which it was said to be taking part in a mixed flight towards the south with *A. maerula* and *C. sennae* (*eubule*) near Caracas, Venezuela, on 25th–26th June 1926 (Box 1930).

Since then Mr. D. B. Legters, of Yucatan, Mexico, has sent me particulars of two large flights. The locality was the village of Xocemplich in the East Central portion of the Yucatan Peninsula in S.E. Mexico.

The first migration started on 20th May 1939 and the insects were flying from S.E. to N.W., the majority just over the tops of the trees, though some possibly 100 feet or more in the air. Fully 100 passed over one square yard per minute. The following day the flight shifted to the west and continued for a week in this direction, every day from about noon till dark. "No matter which direction the wind there was always a definite heading into the west." The flight was suddenly brought to an end by heavy rain on the 30th May (Williams 1939e).

In 1940 the flight was again observed on 22nd June. "Heavy migration heading due south, continued all afternoon, sweeping over and through the tree tops." On 30th June "the heaviest migration of all; the sky is a solid mass of moving pin points, the majority flying high about 100 feet above ground." The flights were, as in the previous year, towards the south and the speed of flight about 4–5 m.p.h.

On the 22nd June, the day of the thinner flight, Mr. Legters took a photograph of the flight with the camera pointing towards the sky. This is reproduced on plate 3. According to his description, the photograph covers an area of about 80 square feet at 30 feet high. It was taken with 1/200 second exposure at F/11. On the original print which was sent about 475 insects can be seen. One can scarcely identify the species of butterfly from it, but it may help to give some idea of the density of the flight to those who have had no opportunity to see such an occurrence.

(4) *Pieris brassicae.*

The Large Cabbage White Butterfly is a regular migrant in Europe. In 1930 I dealt with it in my book (Williams 1930b) and in 1939 I gave a summary of the available information with particular reference to its movements on the continent of Europe up to 1937. In the latter a full list of recent flight records on the continent was given, but the records for Great Britain were only briefly referred to. A very early record for the year 1508 is discussed on p. 103.

The following are a few records up to 1937 omitted from these summaries.

Between 1850 and 1860. Geldebee, nr. Prensburg. To S.
Swarm about a mile broad passing for several days. Schmidt (Sajo 1897, p. 261).

1882, July 18. Nr. Leighton Buzzard, England.
Road between Leighton Buzzard and Gt. Gaddesden blocked by great swarm of butterflies. Proctor (Littleboy 1892).

1885, end July or beginning Aug. Off S.W. coast Sweden. To S.
Two miles off Trelleborg and Falsterbo, air filled with butterflies. Several seen to alight and rise from water (Alsen 1891).

1891, end July. Sweden.
Mass flight, but locality and direction not given (Wahlgren 1912).

1913, Aug. 15. Loch Dan, Wicklow, Ireland. To S.
Mass of butterflies went off suddenly to S. in late afternoon. Evans (Williams 1936a).

1925, Aug. 28. Verona and Mantua, Italy.
Clouds of white butterflies suddenly appeared, filled streets, business at a standstill; all gone after four hours. Newspaper report (Butterfield 1925).

1931, July 28. Weimar, Thuringia, Germany. To S.
Great swarm passing at level of house tops. Janblitzen (Seitz 1931).

1931, July 29. Hochtor Pass : Heiligenblut, S. Austria. To S.
Constant stream of both sexes drifting over snow with north wind. Up to 10 per minute in sight; 20–30 feet in air (Welch 1933).

1932, July 25. Faeborg, Faen Is., Denmark. To S.
Several hundreds visible 1–5 metres over water for two hours. Sunny, no wind. C. Stapel (mss.).

1932, July 30. Middelkerke, Belgium. To S.W.
Big flight (Severin 1932).

Migrations on the continent of Europe 1937–1939.

In 1937 there were extensive migrations, often accompanied by *Pieris rapae* and rarely *P. napi*, in Central Europe. Nineteen references to such flights have already been published (Williams 1939a). Since then the following additional ones have been traced.

1937, May. Schleswig-Holstein. To S. and S.W.
Large swarm near Flensburg and Kreis-Sudtondern (Warnecke 1937).

1937, July. Langenbielau, Silesia. To E.
Migrating for a week quickly and without stopping; mostly 2–3 metres from the ground. Seen also at Snadenfrei in Silesia. Possibly results of unusual heat (30–35° C.) in May (Specht 1937).

1937, July 8. Waldenburger Bergland, Saxony. To W.
Great thick swarm, 10 kilometres broad seen from Fellhammer to Friedland (Hentschel 1937).

1937, July 10. Usedom Is., Baltic coast, Germany. To S.E.
Hatch out of 2nd generation adults at beginning of July. Common everywhere; on 10th great masses started to move to S.E. Urbahn (Wenzel 1937).

1937, July 15. Kefermarkt, Upper Austria. To S.
Hundreds of thousands, fields white. Continued on following days but not so thick (Foltin 1938).
1937, July 15. Schwarzbrunnkopfe, Gablonz, Bohemia. To S.
Masses seen, 875 m. above sea-level. R. Wünsch (Wenzel 1937).
1937, mid-July. Fehmarn, Schleswig-Holstein. To N.
Flight about 4 kilometres long (Warnecke 1937).
1937, mid-July. Kiel.
Very abundant for about a week (Warnecke 1937).
1937, mid-July. Schleswig-Holstein. To S.W.
Great flight 300 metres broad seen near Pelzerhaken in East Holstein, across Neustadter Bay (Warnecke 1937).
1937, July 21. Between Hamburg and Kiel. To W.
Numbers all the way, always 10–15 in sight, apparently mostly females (Warnecke 1937).
1937, July 21. Mardorf, Hanover. To W., S.W., and S.
Flying all afternoon, chief flight 2.30–4.30, when 250–300 passed per minute on 30 metre front. Majority flying over margin of Lake Steinhuder in belt about 70 metres broad. Cloudless, temperature 24–28° C. Calm at first, then about 5 p.m. light W. wind but no change in direction of butterflies (Barth 1938).
1937, July 23. Vöcklabruch, Upper Austria. To S.
Flight seen (Foltin 1938).
1937, July 31. Keller See, nr. Eutin, Oldenburg. To S.
Flight seen on east bank by H. Sick (Wenzel 1937).
1937, Aug. 1. Between Ponitz and Ahrenstock, Oldenburg. To S.W.
Seen by H. Sick in " Middle-Kreis, Eutin " (Wenzel 1937).
1937, beginning August. Reichenau Is., Lake Constance.
Flew one after the other in great numbers; direction not stated. Rethingen (Wenzel 1937).
1937, Aug. 4. The Brocken, Germany. To S.
Flying in groups of 3–8 about 6–10 metres from the ground. Three times as many females as males; about 850 metres above sea-level. Wind very light N. Temperature about 20° C. (Wenzel 1937).
1937, Aug. ?4. Kemtauer, Chemnitz. To S.
All three Pierids flying round; then suddenly, about 3 p.m., went off to south for about 20 minutes; then heavy rain. Ground level up to 10 metres, both sexes equally common. Friedemann (Wenzel 1937).
1937, —. Gratz, S.E. Austria. To W.
Commoner than at any time for ten years. Kraut (Wenzel 1937).
1937, —. Switzerland.
Great damage by caterpillars at Mürren and near Lake Constance (Wenzel 1937).
1937, —. Schilthorn, Switzerland.
A swarm like a snowstorm seen at height of 2600 metres. Hopf (Wenzel 1937).
1937, —. Bad Freienwalde a. Oder, Brandenburg. To S.
Flight reported by Haase (Wenzel 1937).
1937, —. **Stuttgart. To S.**
Swarm observed by A. Koelsch (Wenzel 1937).
1937, —. Jungbuch, Bohemia. To S.W.
Flight reported by Haase (Wenzel 1937).

In 1938 there were no extensive migrations recorded in Central Europe but one record of unusual interest from Sweden which extends the known migration area considerably farther north.

1938, June 20. Straits of Messina. ? To N.N.W.
Thin migration 10.30 a.m. to 1 p.m. Two captured: almost calm. Robertson (Williams 1939a).
1938, Aug. 21. Southern Sweden. To S.
On 320-mile railway journey from Trölleborg to Stockholm large numbers seen; up to 23 visible at one moment; both *P. brassicae* and *P. rapae*. Hodson (Williams 1939a).

In 1939 there was a very extensive invasion in England in August (see p. 193) but only a few records on the Continent and none is available from Central Europe.

1939, July 29. Dieppe, France.

Flight " literally like snow " right up to above the houses, weather fine and clear, wind offshore. Flight seen from train, so direction uncertain. Andrews (mss.).

1939, Aug. 2. Elsinore, Denmark. To S.W.

Mass migration seen " like a snowstorm." " No abnormal numbers at Copenhagen side of ferry 20 miles from Elsinore." J. Smith (mss.).

TABLE 21.

Records of directional flights of *P. brassicae* in the British Isles, 1931–1938.

1931, June 4	Sark, Channel Is.	W.	Droves	Newman 1931
1931, mid-June	E. Dudgeon Light-Vessel, off Norfolk	W.	30 per hour	Sharman
1931, 1st week Aug.	Broadstairs, Kent	—	Great numbers	Newman 1932
1932, July 3	E. Dudgeon Light-Vessel, off Norfolk	W. and W.S.W.	Thin flight	Sharman
1932, Aug. 2	Hove, Sussex	N.	Swarms	V. E. August
1932, Aug. 8	Eastbourne, Sussex	N.W.	Many	R. Adkin
1932, Aug. 8–19	Harpenden, Herts	W.	Thin movement	C. B. Williams (1933a)
1932, Aug. 11	Eastbourne, Sussex	—	Town invaded	Chartres
1932, Aug. 14	Dunwich, Suffolk	W.	Large number	M. B. Ellis (Williams 1933a)
1933, May 12	Broadstairs, Kent	W.	Many	Frohawk
1933, May 21–June 6	Alston, Cumberland	N.	Large numbers	Bolam 1933
1933, May 21–22	Reading, Berks	N.	Small numbers	Hodson
1933, May 21 and 22	Catcleugh, Northumberland	W.	A flight	Craigs
1933, May 22	Droitwich, Worcester	N.	Thin flight	A. B. Williams
1933, June 2	Between Dover and Ostend	N.W.	Hundreds	Gilbert
1933, June 3–5	Scolt Head, Norfolk	W. and S.W.	Considerable immigration	(Turner, *Ent. Rec.* **45** : 127)
1933, June 3–6	Jack Sound, Skomer Is., Pembroke	W.	Thin stream	Lockley
1933, July 20	East Coast, Norfolk	W. and S.W.	Large numbers	Ellis
1933, July 23–30	Nr. Gorleston, Norfolk	W. and S.W.	Hundreds	(*Entomologist* **66** : 210)
1933, July end	Harpenden, Herts	W.	Small numbers	C. B. Williams
1933, Aug. 2	Outer Dowsing Light-Vessel, off Lincoln	E.	20	J. W. Reeve
1933, Aug. 2	E. Dudgeon Light-Vessel, off Norfolk	S.S.E.	Swarm	J. Audley
1933, Aug. 4	Gorleston, Norfolk	N.	Many	E. A. Ellis
1933, Aug. 5	Barrow on Soar, Leicester	W.	Hundreds	C. J. Tatham
1933, Oct. 1	E. Dudgeon Light-Vessel, off Norfolk	E.	Nine	Fuller
1934, July 26	Start Point, Devon	N.	Dozens	A. W. Godfrey
1935, June 9	Scolt Head, Norfolk	S.W.	Dozens	E. A. Ellis
1935, Aug. 5	Start Point, Devon	N.	Dozens	A. W. Godfrey
1936, Aug. 7	Lizard, Cornwall	N.W.	Hundreds	B. A. Cooper
1936, Aug. 17–29	At sea, off Maplethorpe, Lincs	W.	Hundreds	W. R. Withers
1936, Aug. 23	At sea, off Bexhill, Sussex	S.	Dozens	H. G. MacLeod
1936, Aug. 25–26	Harpenden, Herts	S.E.	Dozens	K. Grant
1937, May 24–30	Harpenden, and St. Albans, Herts	N.	Hundreds	K. Grant (1938)
1937, May 24–27	N. Foreland Lighthouse, Kent	W. and W.N.W.	Dozens	H. W. Bowling
1937, May 24	Norwich, Norfolk	N.	Large numbers	E. A. Ellis
1937, May 24 and 25	Blakeney Pt., Norfolk	S.E.	Like a snowstorm	W. Eales
1937, May 27	St. Nicholas Light-Vessel, off Norfolk	W.	A hundred or more	S. G. Sharman
1937, May 30	Gorleston, Norfolk	W.	Many hundreds	M. B. Ellis

TABLE 21 (*Continued*).

1937, May 30	N.W. Norfolk	W.	Large numbers	S. H. Long
1937, June 5–9	Blakeney Pt., Norfolk	S.E.	Thousands	W. Eales
1937, June 6	Nr. Scolt Island, Norfolk	S.W.	Thousands	R. True (3.vii.37, *Field*)
1937, June 6	Burnham-over-Staithe, Norfolk	S.W.	Millions	D. Carruthers
1937, June 6	Sheringham, Norfolk	? S.	Thousands	B. C. Perowne
1937, July 1	Bamburgh Castle, Northumberland	S. and W	Hundreds	W. Wannop
1937, July 28	Owers Light-Vessel, Sussex	S.W. and W.N.W.	Hundreds	W. F. Willgress
1937, July 29	Harpenden, Herts	W.–S.W.	Thin flight	C. B. Williams
1937, July 29	Dover, Kent	N.	Hundreds	B. Embry
1937, July 31–Aug. 7	At sea between Isle of Wight and Chichester	N.W.	Hundreds	C. J. P. Cave
1937, Aug. 1–7	Nr. Hastings, Sussex	N.N.W.	Several hundred	H. Eves
1937, Aug. 3	Nr. Porchester, Hants	S.	Many	A. W. Cother
1937, Aug. 4	Beachy Head, Sussex	N.	About 50	H. C. Gunton
1937, Aug. 14–27	Barmouth, Merioneth	S.	Thin movement	C. B. Williams
1937, Oct. 3	Tynemouth, Northumberland	W.	20–30 from sea	G. L. Drury
1938, May 18–22	Brighton, Sussex	N. and N.E.	Hundreds	H. Blackiston
1938, Sept. 25	Dolgelly, Merioneth	S.	Small numbers	G. van Zuylen

Records in England 1931–1940.

Table 21 gives the records of directional flights observed in England in 1931–1938. Most of them have already been discussed in Williams 1939a. They are summarised in fig. 30. It will be seen that the flights were most extensive in 1933 and 1937, with relatively few in the intervening years. In 1937 there were (see above) many flights observed on the Continent, but in 1933 only very few.

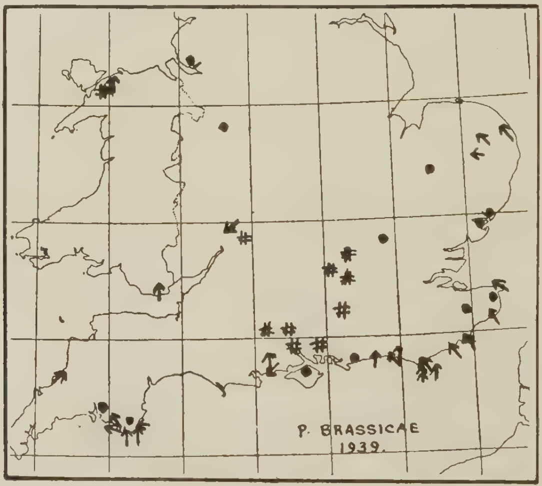

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FIG. 26.—Recorded flights, and unusual abundance of adults (dot), and larvae (cross hatch) of *Pieris brassicae* in England in 1939.

In 1939 there is little doubt that an extensive immigration occurred, particularly along the south coast. The records are shown in Table 22 and the map (fig. 26), which also shows several reports of unusual abundance and damage by larvae which are not listed in the table.

TABLE 22.

Records of directional flights of *P. brassicae* in the British Isles in 1939.

1939, July 11	Royal Sovereign Light-Vessel, Sussex	N.	A few	W. F. Willgress
1939, July 27	Eastbourne, Sussex	N.	Dozens	G. J. T. Jose
1939, July 27	Start Point, S. Devon	W.	Very common	T. C. Abell
1939, July 27	Beachy Head, Sussex	N.	Hundreds	H. G. Adkin
1939, July 28	Bournemouth, Hants	S.W.	Scores	F. C. Fraser
1939, July 29–Aug. 2	North Foreland, Kent	N.W.	Very common	J. W. Bowling
1939, Aug. 1–6	Mid-Norfolk	W.	Large numbers	E. A. Ellis
1939, Aug. 4–8	Eastbourne, Sussex	N.	A thousand	H. G. MacLeod
1939, Aug. 5	Dungeness, Kent	From sea	Hundreds	E. M. Cawkell
1939, Aug. 4–29	Brighton district, Sussex	N. and N.W.	Thousands	H. Blackiston
1939, Aug. 5 and 6	Start Point, Devon	N.	Great number	R. L. Sheppard
1939, Aug. 6	Bexhill, Sussex	N.	Hundreds	H. J. Sargent
1939, Aug. 7–17	Bangor, Carnarvon	N.	General movement	— Jacob
1939, Aug. 8	Hastings, Sussex	N.W.	Hundreds	D. Brightmore
1939, Aug. 8	Alnmouth, Northumberland	—	Suddenly appeared	F. C. Garrett
1939, Aug. 13	Start Point, Devon	N.	Very common	C. H. R. Edwards
1939, Aug. 10–13	Stoke Bay, S. Devon	W. and N.W.	Hundreds	C. B. Williams
1939, Aug. 13	Salcombe, S. Devon	N.	Very common	— Rodick
1939, Aug. 14	Inistrahull Lighthouse, N. Donegal	N.E.	Very common	D. J. Sullivan
1939, Aug. 19	Barry, Glamorgan	N.N.E.	Hundreds	L. R. White
1939, Aug. 20 and 24	Inistrahull Lighthouse, N. Donegal	N.W.	Large numbers	D. J. Sullivan
1939, Aug. 25	Bournemouth, Hants	N.	Hundreds	F. C. Fraser
1939, Aug. 27	Cheltenham, Glos.	S.W.	Over a thousand	F. B. Welch

The main flight started about the 27th July and was at its height in the first half of August. My own observations were made on the South Devon coast at Stoke, where there was a thin flight towards the west for over a week with a peak about the 10th–13th August.

The record of numbers flying towards the north-east at the Inistrahull Lighthouse off the north coast of Ireland is not marked on the map, but is of considerable interest in being the first record of migration from this part of the country. There were also reports of unusual abundance in Perthshire and in Northumberland.

In 1940 there occurred one of the most extensive outbreaks of *Pieris brassicae*, together with smaller numbers of *P. rapae* and *P. napi*, that had been observed for many years in the British Isles. There is little doubt that it was connected with the extensive immigration in 1939, and may have been in part at least the results of a general absence of parasites in the autumn of that year.

It is worthy of note that the winter of 1939–1940 was one of the most severe experienced for many years with minimum temperatures frequently below 10° F. and the ground in many parts frozen or snowbound for from four to six weeks.

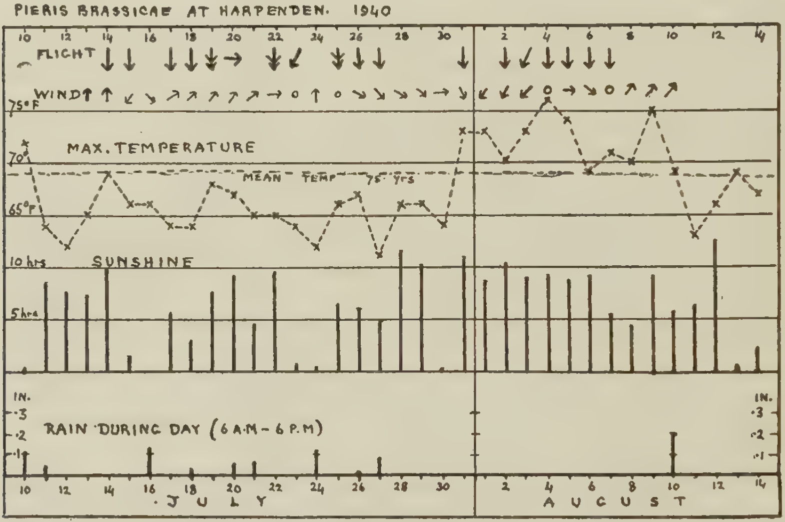
The spring started with records of unusual numbers of white butterflies in many parts of the country, including Kent, North Wales, Buckinghamshire and Gloucester, but only three directional flights were recorded, all in the north, as follows :—

1940, May 18. Morecambe, Lancs. Approximately to S.E.
Procession of butterflies coming in from the sea down the old pier; flying against a moderate land breeze at 3 p.m. All keeping the same course down one side of the pier. Flying in twos and threes, many hundreds passed in 45 minutes' observation. Sea very calm but hazy sky. H. W. Slater.

1940, May 21. Hilbre Is., Cheshire. To E.N.E.
Thousands passing in late afternoon and early evening in calm weather. Flying across the mouth of the River Dee from the Welsh coast; not settling; a hundred every few minutes. H. Blackler (1940).

1940, May 26. Catcleugh, Northumberland. To S.W.
Definite migration seen over eight miles of Hawick Road between Catcleugh and Carters Bar. R. Craigs.

During June and July there were numerous reports of damage by caterpillars to various cruciferous crops, including severe damage to swedes in North Wales and North-east England. In the former area J. Thomas reported that several fields were so damaged that they had to be ploughed up. In the latter area R. A. Harper-Gray reported the worst damage since 1925.



27

Fig. 27.—Summary of observations on a flight of *P. brassicae* at Harpenden in July and August 1940.

The second generation of butterflies began to hatch out about the second week in July, and the first movement was reported at Harpenden on Sunday 14th July. On this date Dr. Henderson-Smith observed a considerable movement of white butterflies to the south over the golf links at mid-day. Forty and fifty were in sight at once and many hundreds passed. The flight was sufficiently obvious to attract the attention of the general public. On the same day C. G. Butler reported them moving to the south in very large numbers for several miles between Royston and Cambridge. This is about 25–30 miles north-east of Harpenden. Thousands were seen and many were dead along the roadside killed by passing traffic. Four of these brought back were 2 males and 2 females of *P. brassicae*. Counts of the numbers crossing the main road within view in five successive minutes gave 76, 121, 102, 85 and 97 respectively.

Movements were also reported on this day from Norfolk, Monmouth and Sussex.

Observations at Harpenden.

From this date until the movement ceased a regular watch was kept at Harpenden, and observations and counts were made at frequent intervals on

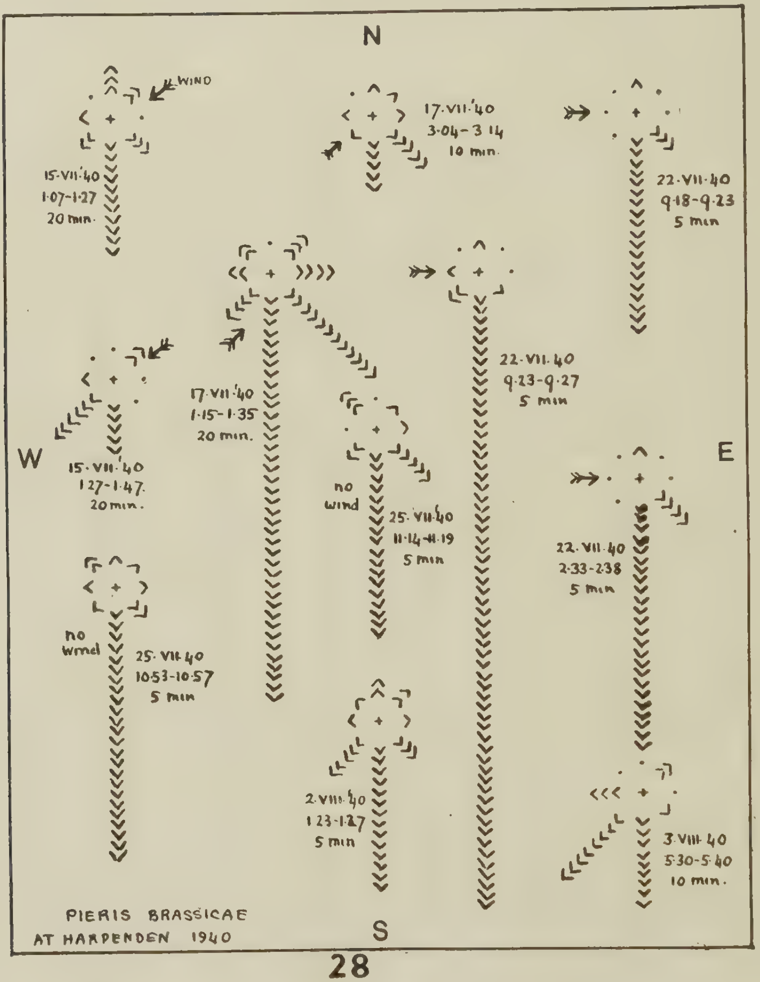
Table 23.

Observations on migrating *P. brassicae* at Harpenden in July and August 1940. For description of localities A, B and C see text.

Date	Time : G.M.T.	Loc.	Min.	Flight		Number to S. per 5 min. per 100 yd.	Group density
				S.	N.		
July 15	1.07	A	20	16	5	4	1
	1.27	A	20	11	2	3	1
July 17	1.15	A	20	55	5	12	2
	3.00	A	10	11	2	5	1
	3.15	B	10	59	14	30	2
July 18	3.10	B	10	17	9	9	1
July 19	8.55	B	25	77	18	16	2
	11.25	B	5	118	18	130	3
	11.30	B	5	89	5	98	3
	1.27	B	10	36	8	20	2
	2.10	B	5	49	2	55	3
	3.36	B	5	8	3	9	1
July 22	9.12	B	5	43	1	48	2
	9.18	A	5	22	1	20	2
	9.23	A	5	62	1	56	3
	9.27	B	5	152	2	167	3
	11.10	C	5	189	4	170	3
	2.30	B	5	48	4	52	3
	2.35	A	5	28	1	25	2
July 25	10.55	A	5	27	4	24	2
	11.00	B	5	44	8	48	2
	11.15	A	5	25	4	23	2
	11.20	B	5	47	5	51	3
July 26	11.35	B	5	35	6	39	2
July 27	11.10	B	5	20	1	22	2
	1.30	B	5	15	5	17	2
Aug. 2	1.25	A	5	22	5	20	2
	1.30	B	5	18	2	20	2
	5.30	A	5	17	2	15	2
Aug. 4	1.45	B	10	31	9	17	2
Aug. 5	1.55	B	10	51	21	27	2
	2.05	A	10	13	4	6	1
Aug. 6	11.40	B	10	55	15	30	2
	1.35	B	10	34	18	19	2
Aug. 7	10.00	B	5	23	3	25	2
	10.05	B	5	14	12	15	2
	1.55	B	5	23	15	25	2
	2.00	B	5	23	14	25	2
Total to date . . .			300	1628	258		
Aug. 9	10.25	B	5	24	24	No evidence of movement.	
	10.30	B	5	19	27	First observations with more to N.	
	4.21	B	5	1	5		
Aug. 12	10.00	B	10	29	14		

each fine day. A summary of the weather conditions during the flight will be found in fig. 27 and a summary of the observations on flight directions in Table 23.

Observations were made chiefly at two points. The first was (Table 23A and fig. 28) on an open cricket ground on Harpenden Common just in front of the Rothamsted Laboratories. The area observed was about 120 yards square. On this field the compass direction (8 points) of each individual was noted.


N
WIND
17·VII·'40
3·04–3·14
10 min.
15·VII·'40
1·07–1·27
20 min.
22·VII·40
9·18–9·23
5 min
17·VII·'40
1·15–1·35
20 min.
22·VII·40
9·23–9·27
5 min
W
E
15·VII·'40
1·27–1·47
20 min.
no wind
25·VII·40
11·14–11·19
5 min
22·VII·40
2·33–2·38
5 min
no wind
25·VII·40
10·53–10·57
5 min
2·VIII·40
1·23–1·27
5 min
3·VIII·40
5·30–5·40
10 min.
PIERIS BRASSICAE
AT HARPENDEN 1940
S

28

Fig. 28.—Observations on compass direction of flights of *P. brassicae* at Harpenden in July and August 1940.

The second (Table 23B) was a strip of common land between the main road and the Laboratories. In this the butterflies were divided into two groups only, those crossing an east–west line of about 90 yards length going to the south, and those going to the north. One set of observations was made on Rothamsted Farm (Table 23C) in an open field across a front of about 120 yards.

In Table 23 there is given in addition to the exact numbers observed a corrected figure for the numbers which would have been observed if the front had been 100 yards and the period of observation five minutes. These are thus comparable for the different localities and different days.

From fig. 27 it will be seen that the first observation was on the 14th July and that the butterflies were passing to the south on almost every fine day until the 7th August, a total of 25 days. The flight started during a period with maximum temperature well below the July average for the locality, which is 69·4° F. The cold spell lasted till the 30th July and then there were 10 days with temperatures well above the average and 8°–10° F. hotter than the previous fortnight. The flight continued steadily during the greater part of this second period, indicating little or no effect of the increased temperatures. The hot spell in August was distinctly sunnier than the cool July, and no rain fell from the 27th July till the 10th August just after the flight had ceased.

The wind, which was from the south on the first day, changed to the north-east on the second, and then changed so frequently that it blew from all quarters except south-east without in any way affecting the direction of the flight. The only noticeable effect was that when it was strong a few butterflies seemed to be carried away with it against their inclination and unusually high in the air.

The standard numbers per 100 yards per 5 minutes shown in Table 23 varied from 3 to 170 and, according to the classification suggested on page 260, included groups I, II and III. Group III, which should be obvious to any field-naturalist, occurred on three days—the 19th, 22nd and 25th of July—and probably also on the 14th, but no exact counts were made on this day.

From the 15th July to the 22nd August continued observations were made for a total of 300 minutes and in that period 1627 insects were counted passing to the south and 256 to the north of an east–west line. If one ends the period at the 4th August the preponderance is considerably greater at 1391—154.

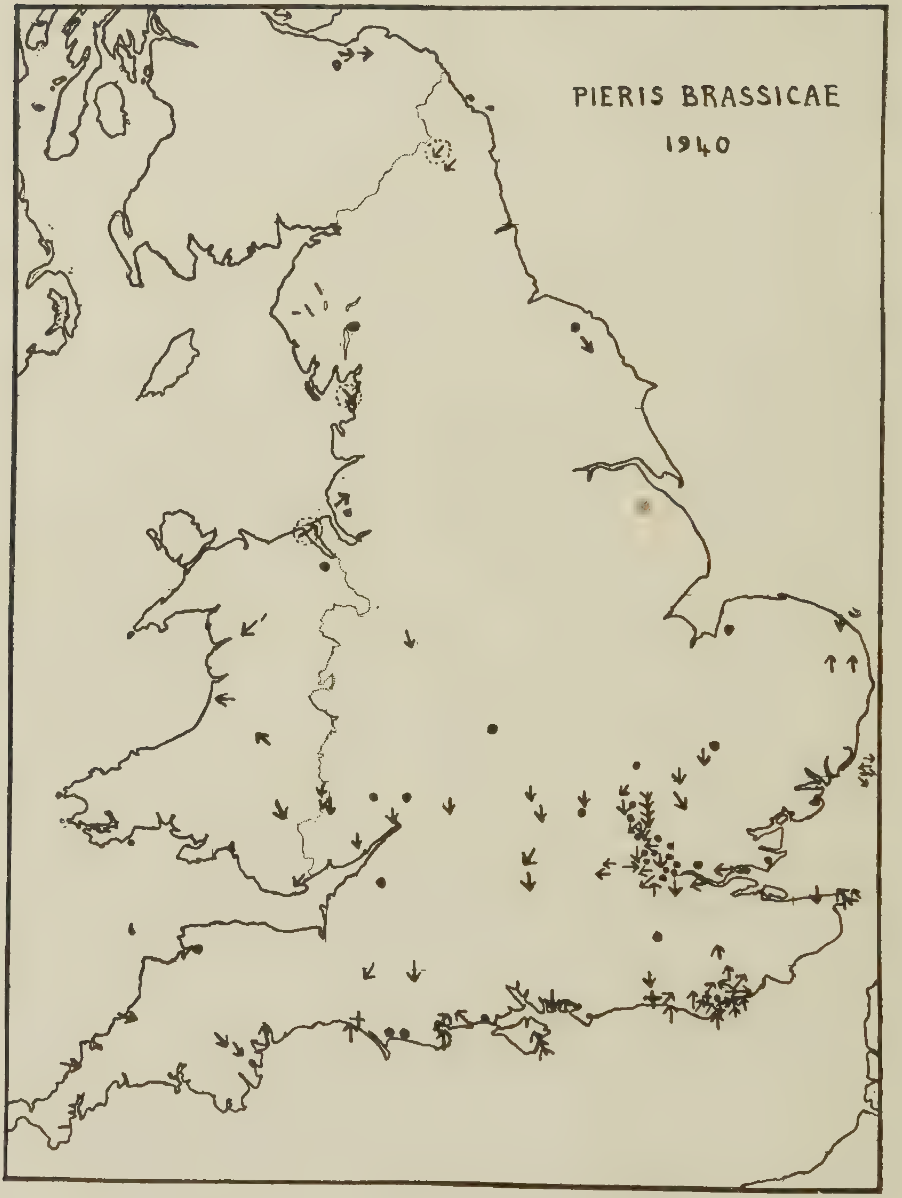
On the 9th August the first observation was obtained since the start of the flight in which the numbers passing to the north were equal to, or greater than, those going south.

Fig. 28 shows the observations made in the open cricket field on Harpenden Common, when the exact compass direction of each individual was recorded. Each arrowhead represents a single butterfly and the overwhelming preponderance of movement almost due south is easily seen. The second commonest direction is south-east or south-west, varying on different days, possibly owing to slight influence of cross winds.

A number of specimens were captured and were nearly all *P. brassicae* in good condition, with a few *P. rapae* and still fewer *P. napi*. For example, on 19th July the captures were :—

	Males	Females
P. brassicae . . .	10	18
P. rapae . . .	3	3
P. napi . . .	1	1

In the passage through the district eggs were laid on various cruciferous plants, and, in my own garden, particularly on nasturtium (*Tropaeolum*). On the whole, however, considerably fewer eggs were laid than might have been expected in the gardens and allotments and no large-scale damage followed in the district. Damage before the flight started had been distinctly more severe.


PIERIS BRASSICAE
1940

29

Fig. 29.—Records of flight of *P. brassicae* in England in 1940.

During the passage of the flight through Harpenden the butterflies were seen on a number of occasions to be attacked by birds, and particularly by sparrows and flycatchers. A small area of the Common just in front of the Laboratories was particularly favoured in this respect and several hundred wings were found on the ground, most frequently in groups of four just as they had been bitten off and dropped by the attacking enemy. One collection of them was sent to Prof. Carpenter at Oxford. The following is a summary of the front wings.

	Female		Male	
	Left front	Right front	Left front	Right front
Sent to Oxford . . .	35	39	15	15
Examined at Harpenden .	117	121	44	39

It will be seen that there are remains of nearly three times as many females as males. Prof. Carpenter (1940) reported that 16 of the left fore-wings and 17 of the right had definite beak marks, which according to Collenette's figures (1935, *Proc. zool. Soc. Lond.* **1935** (2), pl. 1) suggested attacks by Pheasant, Robin, House Sparrow, Starling, Spotted Flycatcher, Great Tit or Blue Tit, and Yellow Hammer or Meadow Pipit or Chiffchaff. There were also many beak marks on the wings retained for examination at Harpenden.

Records outside Harpenden.

Table 24 gives a summary of over one hundred records received of directional flight in other parts of the country, and these, together with some of unusual abundance, are shown on the map in fig. 29.

In England there appear to have been two main movements. The first was to the south through Cambridge, Hertfordshire, Oxford, Shropshire, Gloucester, Somerset and South Wales, occasionally reaching almost to the south coast. The second was a large immigration from the south or south-east all along the south coast from North Foreland in Kent through Eastbourne, Hastings, the Isle of Wight, Bournemouth, Poole, Bridport and South Devon.

In addition to these there were some eastward movements observed in south-east Scotland; one observation of a southerly movement of a very large swarm in Yorkshire; some movements in various directions in Central Wales; and two records of large numbers coming in from the sea on the north Cornwall coast; possibly these latter had come from South Wales.

The butterflies were recorded in unusual numbers all over the country from Fair Isle off the north of Scotland to all parts of England, and in the south of Ireland.

The large numbers of observations round London, shown in the table and on the map, and on the Sussex coast, do not necessarily indicate greater abundance of butterflies, but a greater number of observers and more interest. Many of the London records were obtained through a B.B.C. radio announcement assisted by notices in some newspapers.

TABLE 24.

Records of directional flights of *P. brassicae* in the British Isles in 1940.

May 18	Morecambe, Lancs	S.E.	Many hundreds	H. W. Slater
May 21	Hilbre Is., Cheshire	E.N.E.	Thousands	Blackler (1940)
May 26	Catcleugh, Northumberland	S.W.	Very common	R. Craigs
July 14	Nr. St. Albans, Herts	S.W.	Hundreds	N. L. Birkett (1941)
July 14	Abergavenny, Mon.	S.W. and S.	3–4 per min.	J. B. G. Tulloch (1941)
July 14	Harpenden, Herts	S.	Many hundreds	J. Henderson-Smith
July 14	Hitchin (Herts) to Cambridge	S.	Thousands	C. G. Butler
July 14	Wheatfen Broad, Norfolk	N.	" Good numbers "	E. A. Ellis
July 14–23	Brighton	N.E.	On 23rd very large flight	H. Blackiston
July 15–Aug. 7	Harpenden, Herts	S.	Continuous flight	C. B. Williams (see p. 195)
July 15	Southwick, Sussex	—	Snowstorm	B. Storrell
July 15–30	Norwich district, Norfolk	N.	—	E. A. Ellis
July 15	Slough, Bucks	Mostly W.	Hundreds	B. A. Cooper
July 16	Shipwash Lightship, off Harwich, Essex	E.	Dozens	C. L. R. Torner
July 17	Fairlight, E. Sussex	N.	Very common	—. Shearer
July 17	Hastings, Sussex	N.E.	Very common	A. Belt
July 17	Eastbourne, Sussex	N.E.	Many hundreds	S. J. T. Jose
July 17	Bexhill, Sussex	E.N.E.	Thousands	C. H. J. Sargent
July 17	Crowhurst, E. Sussex	N.	Swarms	C. B. Sharpe
July 17	Hastings, Sussex	E.N.E.	Hundreds	T. Dannreuther and D. Brightmore
July 18–22	Eastbourne, Sussex	W. on 19th	Hundreds	C. H. Hutchinson
July 18	Bexhill, Sussex	From sea	—	H. D. Peile
July 18–25	Portsmouth, Hants	S.	Considerable flight	Lt.-Col. Baker
July 19	Guestling, Sussex	N.	Large numbers	Mrs. Addison
July 19	Bexhill, Sussex	Up the Valley	" Millions "	Reported to H. D. Peile
July 19	Herne Bay, N. Kent	From the sea	Swarm	M. Greenfield
July 20–27	Bexhill, Sussex	E.	Thousands	H. J. North
July 20–Aug. 6	Tring, Herts	S.E.	" Influx "	A. H. Bishop
July 21–27	Newbury, Berks	S.	Large numbers	A. S. Williams
July 21	Shipwash Lightship, off Harwich, Essex	W.	Dozens	C. L. R. Torner
July 22	Shipwash Lightship, off Harwich, Essex	E.	Dozens	C. L. R. Torner
July 22–23	Farnborough, Berks	S.W.	Thousands	W. Groves
July 22–23	North Foreland Lighthouse, Kent	N.W.	Hundreds	H. W. Bowling
July 22	Ruislip, Middlesex	E.	Hundreds	P. A. Buxton
July 22–25	Burgess Hill, Sussex	S.	Large numbers	F. Balfour-Browne
July 23	Oxford	S.	Large numbers	G. D. H. Carpenter
July 23	St. Albans, Herts	S.	Thin flight	D. Brightmore
July 23–25, and Aug. 1	Aberystwyth, Cardigan.	W.	Thin movement	J. R. W. Jenkins
July 24–29	Nr. Boscastle, N. Cornwall	E.	Passing for 5 days	S. E. Clark
July 24	Builth, Brecknock	N.W.	Up Wye Valley	J. R. W. Jenkins
July 24–25	Walcot on Sea, Norfolk	S.	Several	K. Love
July 25 and 29	Harrow, Middlesex	W.	Very large numbers	E. Stone
July 25	Eastbourne, Sussex	From the sea	Hundreds	E. C. Arnold
July 25	Hastings, Sussex	Most S.E.	Very common	T. Dannreuther
July 25	Bexhill, Sussex	E.	Scores	H. D. Peile
July 25 and 26	Eastbourne, Sussex	E. and E.N.E.	Thousands	G. J. T. Jose
July 25–29	Brighton, Sussex	N.	Thousands	H. Blackiston
July, end	Hastings, Sussex	E.	Very common	T. Dannreuther
July, end, to mid-Aug.	Edinburgh	Gen. to E.	Unusual numbers	A. E. Cameron
July, last week	Shaftesbury, Wilts	S.	Millions	C. M. Coventry
July, last week	Watford, Herts	S.	Large numbers	J. E. Allen
July, last week	Highgate, London, N.6	S.	1 per sec. in sight	Mrs. J. B. Priestley
July, end	Bricket Wood, Herts	S.E.	Like snowstorm	N. L. Birkett
July 26	Welling, Kent	W,	Very large numbers	Mrs. Hichmott
July 26–29	Maidenhead, Berks	W.	Steady procession	I. Mees
July 26	Grays, Essex	W.	Hundreds	K. R. Luten
July 26	Bexhill, Sussex	N.	—	H. D. Peile
July 26	Shanklin, I.O.W.	N.N.W.	Many thousands	C. S. Best
July 26	Milford-on-Sea, Hants	—	Sudden swarm	W. Burton
July 26	Eastbourne, Sussex	—	A second immigration	C. H. Hutchinson
July 26	Hastings, Sussex	N.E.	About 100	A. Belt
July 26 and 27	Hastings, Sussex	N.E.	Hundreds	T. Dannreuther
July 27	Crowhurst, Sussex	E.	Thousands	G. W. Seedbury
July 27 and 28	Catford, London, S.E.6	S. or S.E.	Large numbers	H. Fuller
July 27	Worcester Park, Surrey	N.	Hundreds	J. J. Ketchall
July 27	Dolgelley, Merioneth	S.W.	Flying down valley	J. R. W. Jenkins
July 27	Hounslow, Middlesex	S.W.	Hundreds	F. Coulston
July 27	Hastings, Sussex	W.	Massed	A. J. Cruttenden
July 27	Hastings, Sussex	To E.	Flock	G. W. Seedbury
July 27–28	Lydiate, nr. Liverpool	N.E.	Large numbers	J. Clark
July 28–29	Sandhurst, Kent	N.	Unusually abundant	G. V. Bull
July 28	Beachy Head, Sussex	N.	Great numbers	C. H. Hutchinson
July 28	Crowlink, Sussex	N.E.	—	C. J. T. Jose
July 28	Hastings, Sussex	E. (most)	Thousands	T. Dannreuther
July 28	Eastbourne, Sussex	N. and E.	Thousands	C. H. Hutchinson
July 29	Shipwash Lightship, off Harwich, Essex	S.E.	Dozens	C. L. R. Torner

TABLE 24 (*Continued*).

July 29	Canford Cliffs, nr. Poole, Dorset	To N.E.	Groups coming in from sea	J. Heath
July 31	Cardiff, Glamorgan	S.W.	Steady movement	G. F. Cockbill
July 31–Aug. 5	Hove, Sussex	From sea	Up to 20 at a time	G. Eade
Aug., beginning	N. Somerset and S. Gloucester	N.	Invasion	C. L. Walton
Aug., early	North Wootton, Norfolk	—	Enormous cloud	N. Tracey
Aug. 1	Bridport, Dorset	N.	Air filled. From the sea	A. Curtis
Aug. 1	Cataleugh, Northumberland	S.W.	Very common	R. Craigs
Aug. 2	Hastings, Sussex	E.	Common, but only few moving	T. Dannreuther
Aug. 2–6	Hove and Brighton, Sussex	N.	Coming in from sea	E. J. Eade
Aug. 3–4	Newquay, Cornwall	E. or S.E.	Large numbers from the sea	—. Abel
Aug. 3	Newport, Salop	S.E.	Numbers	H. C. F. Newton
Aug. 4	Abergavenny, Mon.	S.S.W.	5–6 per min.	J. B. G. Tulloch (1941)
Aug. 4–11	Torquay, Devon	—	Swarming	B. A. Thorn
Aug. 4	Poole, Dorset	N.	Thousands from sea	A. Bromby
Aug. 4	Horam and Vines Cross, Sussex	N.E.	Thousands	L. R. Eaton
Aug. 5	Dawlish, S. Devon	W. and N.W.	About 200 per hour	D. C. Thomas
Aug. 4	Goathland, Yorks	S.E.	Like snowstorm	W. S. Medlicote
Aug. 5	Chepstow, Gloucester, Oxford and Thame	S.	Thin steady movement	G. F. Cockbill
Aug. 7	Buntingford, Herts	S.E.	Thousands	D. A. Boyd
Aug. 8–17	St. Albans, Herts	S.S.E.	Thin movement	D. Brightmore
Aug. 10	Bournemouth, Hants	N.W.	1000 per hour	A. Bromby
Aug. 15	Dunblane, S. Perthshire	E. and N.E.	Unusual numbers	A. E. Cameron
Aug. 16	Black Mts., Monmouth	S.S.E.	2–3 per min. 50 yds.	P. A. Buxton
Aug., mid	Lothians, Scotland	? to E.	Snowstorm	Newspaper report
Aug. 25	Cordom Tor, S. Devon	S.E.	Many	C. G. Butler
Aug., end	Newton Abbot, Devon	S.E.	Still obvious	C. G. Butler
Sept. 7	Sparkford, Dorset	S.S.W.	Dozens	C. G. Butler

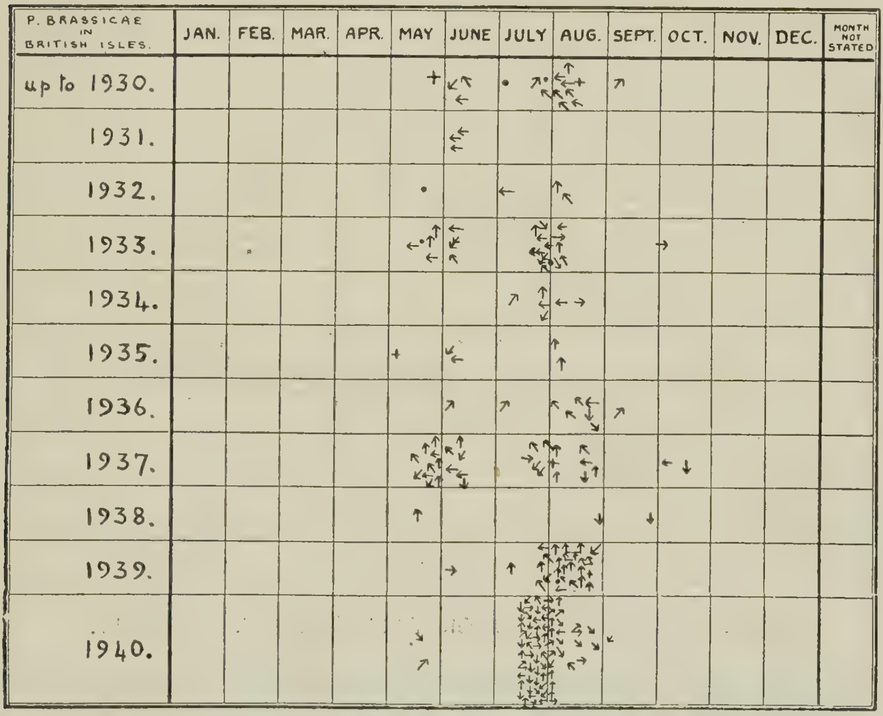


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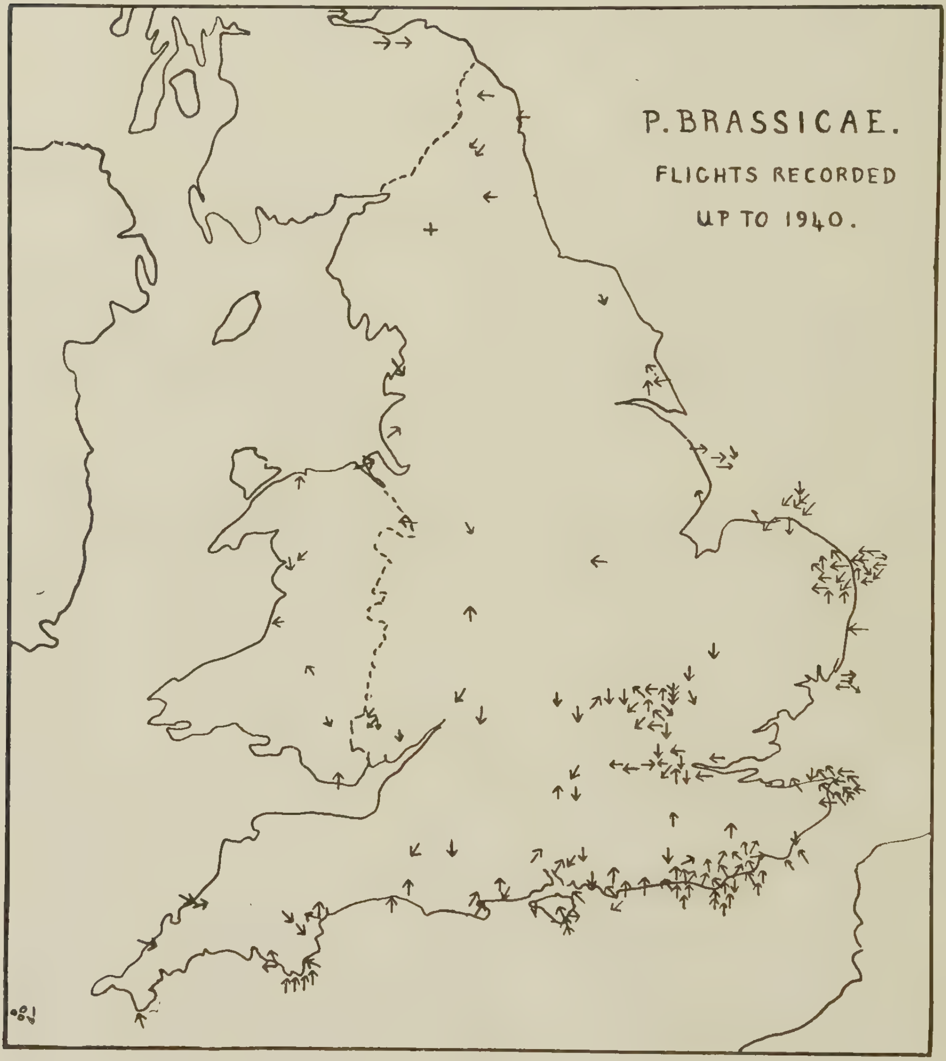
FIG. 30.—Diagram of recorded flights of *P. brassicae* in the British Isles.

General summary of all records.

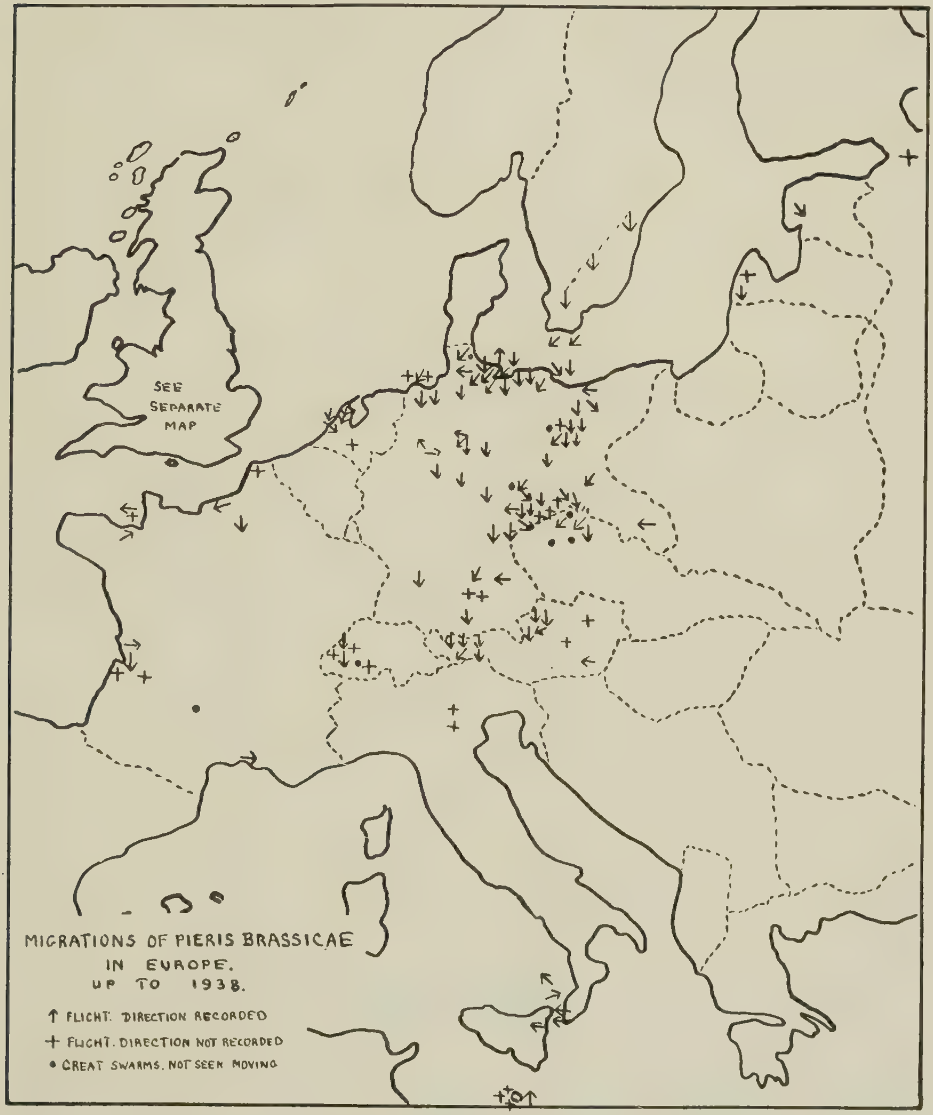
Finally, fig. 30 and the maps of England and of the Continent in figs. 31 and 32 give a complete summary of over 300 records so far collected of directional flights of *P. brassicae.*



31

Fig. 31.—Map of all recorded flights of *P. brassicae* in the British Isles.

From fig. 30 it will be seen firstly that records since 1930 have far outnumbered those relating to earlier years. This is not a biological fact, but is due to greatly increased interest in the problem. Secondly, that the chief migration years in England since 1930 have been 1933, 1937, 1939, and 1940, the latter having by far the most widespread and striking movements. Thirdly, that the two main seasons for migration to occur in England are (1) the end of May and beginning of June and (2) the end of July and first half of August. These two seasons are also found on the Continent but there (Williams 1939c) the second season is very much more important than the first.


SEE SEPARATE MAP
MIGRATIONS OF PIERIS BRASSICAE IN EUROPE. UP TO 1938.
↑ FLIGHT. DIRECTION RECORDED
+ FLIGHT. DIRECTION NOT RECORDED
• GREAT SWARMS. NOT SEEN MOVING

32

FIG. 32.—Map of all recorded flights of *P. brassicae* in Europe.

Fig. 33 shows a summary of all flight directions for these two seasons in England and on the Continent. In England both seasons give flights preponderating to W. and N.W. On the Continent the first season is rather vague but the second is overwhelmingly to the south.

The map of England (fig. 31) shows the large numbers of records of migrations round the East and South coasts, and also the effect (in increased number of records) of specially interested observers at Harpenden (about 25 miles N. of London) and at Hastings.

The map of the Continent (fig. 32) shows the very definite southward movement which appears to start in Scandinavia, passes south, particularly through East Germany, and the Tyrol, and apparently breaks up against the mass of the Alps.

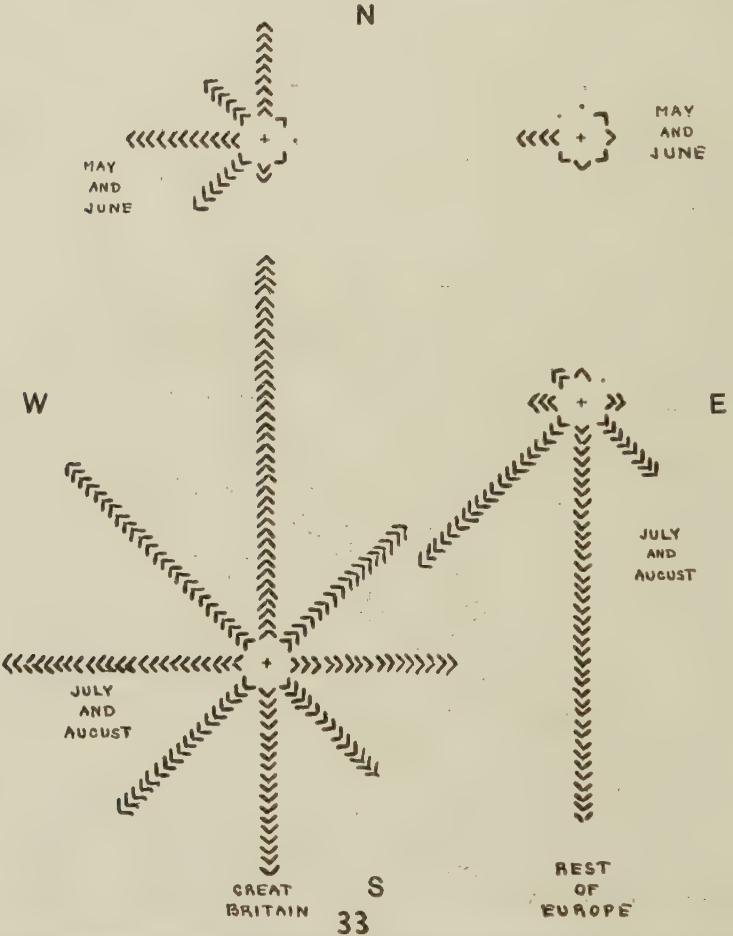


Fig. 33.—Direction of flights of *P. brassicae* in the two flight seasons in Great Britain and on the Continent.

There are also a few records in the Mediterranean, discussed more fully in Williams 1939a, that do not as yet fit in with any scheme.

(5) *Vanessa cardui.*

Since my previous review of the species (Williams 1930b : 168–212) the following records have been received for the European area :—

1918, May 11. Lustenau, Vorarlberg, Germany. To N.

Many in early afternoon; by 4–6 p.m. very abundant; hundreds seen in an hour, flying very fast. Hammerle (Seitz 1918).

1918, May 17. Oberturkheim, Neckartal, Germany. To N.W.

Many flying 2–4 p.m.; very thick on left bank of Neckar River; flying singly but always 4–5 in sight: fresh condition; flying very fast. Karlgraf (Seitz 1918).

1928, May–June. Scilly Islands.

First seen 31st May, increased to swarm on 3rd June. Frohawk (*Entomologist* **61** : 172).

1928, end May and June. British Isles.

Great numbers appeared in Kent. Theobald (*Entomologist* **61** : 234). Swarming at Margate on 8th June. Higgins (*loc. cit.* : 952). In extreme abundance at Torquay on 15th June. Morgan (*loc. cit.* : 182). Larvae common at Aberdeen on 17th June.

1928, Aug. and Sept. England.

Numerous records of abundance.

1928, Autumn. Skama, Sweden.

Common (Wahlgren, E., 1928a).

1929, May 28. Hastings, England. To N.E.

Dozens seen flying from 2–5 p.m. on hot day after cold wet spell. Steady rapid flight to N.E. (J. Jones mss.).

1930. England.

Only very few records and several notes on rarity.

1931, May 3. Cavalaire, Var, France. To N.

Very many in groups of 1–7 close to ground, after violent storm from the S.E. (Eliot mss.).

1931, May 24. Schwab-Hall, Würtemberg, Germany. To N.E.

Flying 5–6 p.m. every half-minute, always 2–3 in sight, about 200 altogether, flying with the wind (Renner 1931).

1931, May 24. Flims, Graubünden, Switzerland. To N.W.

From morning to evening in quick flight. Corti (Warnecke 1931).

1931, May. Leysim, Switzerland. To N.E.

Flying in numbers. Dr. G. Marburg and P. Eschwege (Warnecke 1931).

1931, May 25. Zurich, Switzerland. To N.E. (by compass).

Flying along railway track, one per minute, out of sight of each other. Temperature 30° C. (Fischer 1937).

1931, May end. Ozoir la Ferrière, nr. Paris, France. ? To N.

Flight seen by R. Oberthur (Mezger 1932).

1931, May end. England.

Arrived in great numbers on Sussex coast on 27th (*Ent. Rec.* **43** : 111). Invasion of great numbers in Devon on 29th May (*Ent. mon. Mag.* **67** : 160).

1931, June 3. Ozoir la Ferrière, nr. Paris, France. To N.

A hundred passed singly very fast (Mezger 1932).

1931, June 4. Sark, Channel Island. ? To N.

Numbers coming in from the sea with *P. brassicae* from French coast. Newman (*Ent. Rec.* **43** : 185).

1931, July 12. Edinburgh, Scotland.

One seen (C.B.W.).

1931, July 5. Bardon Hill, Leicester, England. ? To S.W. by W.

Hundreds in migratory flight on warm sunny afternoon (D. P. Lewis mss.).

1931, July 23. St. Leonhard, Pitztal, Tyrol. To S.

Thousands flying singly on Blockkogel (3098 m.) from 11 to 12 a.m. in spite of low air temperature. Again seen 1–2 p.m. (Bergmann 1931).

1931, July–Aug. St. Kilda, Outer Hebrides, Scotland.

Seen almost every day from 24th July to 10th August. Lack (*Ent. mon. Mag.* **68** : 143).

1931, end July. Stockholm, Sweden.

Three females captured. Richter (Seitz 1931).

1931, Aug. Iceland.

One captured at Flateg, Breidafjordur, and four at Skjaldvarafoss. M. Bjornson (Reykjavik N.H. Mus.).

1931, Aug. 3. Belvedere, nr. Champex, Switzerland. To S.S.E.

Flying continuously in groups of 5–6 from 11 to 12 a.m., a few feet below the Belvedere Ridge on west side at altitude of about 5500 feet. Clear sunny day. Thackeray (Williams 1933b).

1931, Aug. 4 and 5. Near Bludenz in Vorarlberg, Austria. To S.

Many hundreds flying to south, seen for many hours on the 4th and from 8 a.m. on the 5th. Also seen on Mondspitz 2000 metres high (Lenz 1931).

1931, Aug. 20. Val d'Arpette, Switzerland. To W. of S.
One or two per minute on 100-yard front across top of valley. Thackeray (Williams 1933b).

1932, May 21. Bohnabreena, Co. Dublin, Ireland. To N.W.
About 8 passing 3–4 p.m. in steady rapid flight, wind light N.W. (C. C. Ellison mss.).

1932, May 25 and 26. North Foreland, Kent. To W. and N.W.
Small number passing, wind N.–N.E. (Bowling mss.).

1932, June end. Balancourt, nr. Corbeil, Seine et Oise, France. To N.N.E.
Flight of many thousands, 10 a.m. to 1.30 p.m., flying at level of the tree tops in belt not more than 15 feet wide. Fine, no wind. Gastineau (Williams 1939d).

1932, Aug. 9. Winchelsea, Sussex. To W.
Small number, very fast and lively (Tomlin mss.).

1932, end Sept. Arosa, Switzerland. To S.
Flight observed coming over the " Obersee " for many hours without change of flight line. Fischer (1937 : 67).

1932, Sept. or Oct. Iceland.
One captured at Faqurholsmyri in S.E. of Iceland and now in collection of Reykjavik Museum. (G. Gigja in letter to T. Dannreuther.)

1933, May 19. Start Point, Devon. To W.
About 9 seen coming in from the sea about 3 p.m., calm. Temperature about 58° F. (Godfrey mss.).

1933, May 28 and 29. Start Point, Devon. To N.
Small numbers seen. Wind E. and S.W. (Godfrey mss.).

1933, June 1–27. Start Point, Devon. To N., N.W. or W.
Every day twenty to thirty seen in rapid flight inland (Godfrey mss.).

1933, July to Sept. Reykjavik, Iceland.
Several seen on 19th July; very common on 8th and 9th August; ten seen on 9th September. G. Gigja. Two in collection of Reykjavik Museum.

1933, Oct. St. Marys, Scilly Islands. To S.
During first fortnight hundreds of *cardui* and *atalanta* about, chiefly going south, all gone about 16th (R. Trotter mss.).

1934, beginning of Aug. Swanage, Dorset. To W.
Steady flight across sea from Isle of Wight towards Swanage (Jobling mss.).

1935, March 9. Lydda, Palestine. To N.
Thousands seen at 11 a.m. Wind light S.W. Dallmeyer (27.xii.1935, *Times*).

1935, March, end. Cyprus. To W.
Large number seen flying to W. at Nicosia. Damage by larvae in April and May. Not seen and no damage later in year. Morris (*Ann. Rept. Dept. Agr. Cyprus* 1935).

1936, June 19. Scilly Islands. To N.
About 20 seen. Wind light S.E. (Trotter mss.).

1936, June 21–26. Isle of Wight. To W. and N.W.
About 200 seen passing. Rapid flight on 21st and 26th (Buckstone mss.).

1936, Oct. 1–10. St. Marys, Scilly Islands. To S.E.
Scores passing, wind E. and S.E. (R. Trotter mss.).

1937, May 29. Near Rye, E. Sussex, England. To N.
Steady trickle of ones and twos coming inland from the sea from 4.30 to 8 p.m. Fine and warm. Wind light N.E. (Ticehurst mss.).

1937, June 11. Round Island, Scilly Islands. To N.N.E.
Dozens passing 1–6 p.m. Sunny, wind light S. (Trotter mss.).

1937, Aug. 1–7. Nr. Hastings, Sussex. To N.N.W.
About one hundred seen coming in from the sea about 3 feet above the water. Sunny and warm, no wind (Eves mss.).

1939, May 28. Ionian Sea, Mediterranean. To S.E.
Migration observed in lat. 36° 40′ N., long. 18° 22′ E., about 150 miles S.E. of Italy (H.M. Naval Vessel report).

1939, May 18–June 19. Cavalaire, Var, France. To N., N.E. and N.W.
Seen passing almost every day (N. Eliot 1939, mss.).

1939, May 31. Nr. Dartmouth, Devon. To N.
About forty seen coming in from sea flying high and not stopping (Brown mss.).

1939, June 7. St. Marys, Scilly Islands. To N.W.
Dozens passing, bright warm day. Wind N.E. (R. Trotter mss.).

1939, June 7. Riehen, nr. Basle, Switzerland. To E.
Migration from 11 a.m. to 4 p.m., like a snowstorm in p.m. (newspaper report).

1939, June 8. Rennes, W. France. To N.

Many hundreds passed noon to 3 p.m. Weather stormy with occasional sun, warm, wind moderate west (R. Oberthur mss.).

1939, June 8. Chiemsee, nr. Munich. To N.E.

Migration according to newspaper report.

1939, June 5–12. Garonne and Dordogne, France.

Extraordinary passage, literally all over the place. Sabastian (Muspratt *in litt.*).

1939, June 19. Savoie, France. To N.W. and N.E.

Thin migration, 3 per minute on 50-yard front at junction of Isère and Arc Rivers. Mostly to N.W. with about 8% up a valley to N.E. (Eliot, 1939 and mss.).

1939, July. N.W. France.

Very heavy damage by caterpillars to artichoke, in Brest–Finistère district (newspaper report and letter from M. Cusson).

It will be seen that the recent years of unusual abundance were 1928, 1931, 1937 and 1939. In 1930, 1934, 1935 and 1938, on the contrary, there were very few records. Estimates of the numbers recorded each year for 1928–1931 will be found in Table 4, and a discussion of the earlier history on p. 114.

It is interesting to note that in the above list there are only three records of flight in September and October and they are all in a southerly direction as follows :—(1) 1932, end Sept., Switzerland to S.; (2) 1933, begin. Oct., Scilly Islands to S.; (3) 1936, begin. Oct., Scilly Islands to S.

The problem of the return flight is dealt with on p. 242.

V. cardui in the Atlantic and in West Africa.

A number of records are now available for the occurrence of *V. cardui* in West Africa and at sea off the West African coast. The following is a summary of the evidence.

At Sea.

1858, May 28. Off Teneriffe.

One captured 90 miles west of Teneriffe. Trimen (1873, *J. Linn. Soc.* **11** : 276).

1866, Sept. 16. Off Cape Verde Islands.

Many seen about 200 m. from Cape Verde Islands and about 600 miles from Gambia. Herbert (1867, *Entomologist* **3** : 266).

(? 1891.) Off N.W. Coast of Africa.

Many thousands fell exhausted on deck of sailing vessel several hundred miles from shore, for nearly 24 hours. Buckstone (1926, *Entomologist* **59** : 171).

1904, end Sept. or early Oct. Off Cape Verde.

Several seen about 47 miles from land. Manders (1905, *Ent. Rec.* **17** : 235).

1932, Sept. 28. S. of Madeira.

Flight between 11 p.m. and midnight in lat. 17° 47′ N. and 17° 35′ W.; 87 miles from land. Twelve captured, four males and eight females. D. Kingdom (Poulton 1932b and 1933b and c).

1935, Sept. 28. Between Cape Verde Islands and Coast.

Ship steamed all day through swarm of many hundreds: moderate N.E. trade wind. J. S. Hudson (Riley 1936).

It will be noted that in four of the five records in which the month is given, the period is September or October. The only exception (Trimen 1858) relates only to a single individual.

In Nigeria.

There is also considerable evidence to show that in Nigeria the species becomes suddenly abundant year after year at just the same period. Records are available for 1928–1936.

In 1928 *V. cardui* appeared in the Benue Province towards the end of September and were still abundant at the end of October. At Kafsina Ala on the 27th September there were hundreds and many pairs mating (O. B. Lean).

In 1929 it was seen at Ibadan on 25–27th September and at Ilorin (N. Nigeria) from the 9th to 14th October in some numbers and a few till the end of the month (O. B. Lean). At Arochuku Heslop (1931) reports a small immigration at the same time as in 1930 (*q.v.*).

In 1930 it was first seen at Bende on 1st October and increased rapidly in numbers, always faded and sometimes frayed. By mid-October " almost every patch of intensely hot bare soil on the paths and open hill sides had its *cardui*." It was generally abundant but by the end of October the numbers had begun to decline and by 9th November hardly a specimen was to be seen (Heslop 1931). Heslop considers that there had been " a large migration on the southerly and south-easterly breezes of late September."

According to O. B. Lean, it appeared in this year in Ibadan on 25th September but not in large numbers.

In 1931 Heslop (1932) records the first one seen at Okigwi in S.E. Nigeria on 15th September and by the end of the month it was possible to see a dozen at once. They were also in small numbers at Port Harcourt from 6th to 15th October.

In 1932 the first were observed at Port Harcourt on 29th September (Heslop 1935) and two or three were seen most days during October; the last here was on the 2nd November. A few, however, were seen in the north of the province on the 5th November.

In 1933 Heslop was away during the normal *cardui* season, but on his return he saw one individual at Okigwi in the extreme north of the province on 22nd November (Heslop 1935).

In 1934 a small and battered female was seen at Okigwi on 16th May, a faded male came to light on the evening of the 17th June and another on the following night. The normal arrival was a little later than usual and the first specimen was seen by Heslop (1935) on 4th October at Orlu; they had, however, already been seen at Okigwi on the 16th–22nd September by Lipscomb. They think that the flight originated on the edge of the Sahara desert, which is about 200 miles to the north of Kaduna, and had worked its way south. The last specimen was seen on the 11th November and the species was much rarer than usual.

In 1935 Golding (Williams 1936a) reports that he saw one on 8th July, which was the first that he ever recollected occurring at that time of the year; later four were seen on 30th September, which he says is the normal time of the year. Heslop (1937) reports that in this year he saw no May–June individuals. He was away later in the year but was informed that there was a sparse appearance in October and the early part of November.

In 1936 the September–October flight failed completely and Heslop (1937) saw only one individual near Obetin on the 5th October.

There is no doubt from the above evidence that there is considerable migration activity of *Vanessa cardui* in that area of West Africa south of the Sahara in the months of September and October, and one is tempted to suggest that there may be a southward migration from the edges of the desert belt at this time of the year corresponding to the northward movement about March. There is unfortunately a great scarcity of accurate records any farther south on the coast so that the suggestion cannot be confirmed. One must, as so frequently occurs in this study, await further evidence.

A remarkable record of the occurrence of *V. cardui* in mid-Atlantic is worth while drawing attention to here. Mathews (1865) records that on 4th August 1865 he was on board a battleship standing by the " Great Eastern " while she was laying the Trans-atlantic cable. The position was 51° 33′ N. and 38° 17′ W. The sea had been dead calm, " as smooth as glass " for several days. A " Painted Lady " butterfly was found alive floating on the surface of the sea, and about noon another was seen flying round the ship and continued to do so for the whole of the afternoon. The position is in the North Atlantic about 1100 miles due west of the south of Ireland and 500 miles east of Newfoundland.

Just over two weeks later they entered the harbour of St. John, Newfoundland, and found *V. cardui* in the greatest profusion, as it had been in Cork, Ireland, in mid-July.

It is almost impossible to believe that these butterflies had been unnoticed on the ship since leaving the Irish Coast three weeks before. The butterflies must have flown to the position when they were found.

(6) *Glycestha aurota* (= *Belenois mesentina* Cr.).

The following new records have come to hand since the publication of my previous summary (Williams 1930b).

1927, 1928 and 1929: Oct. and Nov. Pretoria, Transvaal. To N.
Vast numbers in early summer of each year. " One butterfly to every 10 yards in four or five tiers." As far as eye could see in all directions for one or two hours. E. G. Smith (Williams 1939b).

1928–29, Summer. Boshoek, Rustenburg, Transvaal. To N.
Myriads on a warm afternoon with no wind: flight from 2 p.m. to dusk. Some low enough to go through fences, others above scrubby bush. No attempt to settle. Flying about 25 feet apart (G. W. Hockey mss.).

1930, Feb. 11–April 9. S.E. Kenya and N.E. Tanganyika. To S., S.E. and E.
Sixteen records received of flights between Mbule and Kikori in west, Ngari Nairok and Voi (in Kenya) in north, Korogwe in south and the coast on the east, an area of about 280 by 150 miles (reported fully in Williams 1931).

1931, Dec. Barberton, Natal. To N.E.
Large numbers passed over for 2 or 3 weeks. Pearson (Williams 1936a).

1932, Jan. 28. Londiani, Kenya. To E.N.E.
Small but definite migration in teeth of steady breeze from E.N.E. Middle of dry season, no rain for six weeks. Some *C. florella* in flight. R. M. Graham (Williams 1933b).

1932, April 8–11. Londiani, Kenya. To E.N.E.
A second migration, no rain for nearly two weeks. Many specimens sent, all *G. aurota.* R. M. Graham (Williams 1933b). (Note that a few days later specimens were sent from a continuation of this flight and they were all *G. creona = severina.*)

1932, Dec. Barberton, Natal. To N.E.
Passed over for two or three weeks. Pearson (Williams 1936a).

1932 or 1933, March or April. Nr. Salisbury, S. Rhodesia. To S.E.
Steady stream of millions of white butterflies from 5.30 a.m. all one day and part of next—flying 10–15 feet above ground (G. T. Bennett mss.).

1933, March 1–15. Amani, Tanganyika. To E.N.E. and S.S.E.
Slight migrations from 1st March to E.N.E., but not noticeable to casual observers till 11th March, when it changed to S.S.E. and passed in larger numbers till 15th. Moreau (Williams 1935d).

1933, March 8. Limuru, Kenya. To N.
Started this year about 8th March instead of usual January and flew to N. instead of more usual S. Weather hot and little rain. Wind from south which was also unusual. Knight (Williams 1935d).

1933, March 12 and April 10. Londiani, Kenya. To N.N.E.
Most days wind strong from N.E. or N.N.E. Flight 10 a.m. to 4 p.m. Weather mostly bright and clear; rains overdue. Max. flight 100 insects per 100 yards square on 21st March. Graham (Williams 1934d).

1933, March 19–20. Njoro, Kenya. To N.

Flying in millions in unusual direction, flight normally to south. Dawson (Williams 1935d).

1933, March 28. Molo, Kenya. To W.

Passing for several days. Dawson (Williams 1935d).

1933, May, 1st week. Londiani, Kenya. To N.E. and N.N.E.

Small migration in usual direction, usually against the wind, rains about two months overdue. On 5th and 6th May up to 20 butterflies on 100 sq. yards. Graham (Williams 1935d).

1933, June 15–16. Gulf of Aden. ? To N.E.

Off Cape Gardefui and in Gulf of Aden; migrating from African Coast towards Arabia. Stoneham (Williams 1939b).

1933, July, about 5th. Off Cape Gardefui. To N.

Hundreds flying in face of N.E. monsoon. Seen from ship about 2 miles from shore. Several came to rest on deck. Flying from close to waves up to about 100 feet. Clear, hot (D. W. Bowell mss.).

1934, Jan. Serowe, Bechuanaland. To N.E.

Millions crossed over, also reported 20 miles farther north (newspaper report).

1934, Jan. 20. Pretoria to Belfast, Transvaal. To E.

White butterflies flying in numbers. DuToit (Williams 1935d).

1934, Jan. 24. Potchefstroom, Transvaal. To N.E.

Vast numbers passed in afternoon. 100 in ten minutes passed a given point. Reported also from Johannesburg (D. P. Murray mss.).

1934, Jan., end. Lydenburg, Transvaal. To E.

Invasion of millions. Continuous stream seen all way from Petersburg to Rustenburg (newspaper report).

1934, Jan. and Feb. Windhoek, S.W. Africa. To N.W.

Migrating day after day across or with the wind on hills at about 1800 metres. One individual every 5 sq. yards. Occasionally stop to feed (K. Jordan 1936).

1934, Feb., beginning. Johannesburg, Transvaal. To E.

Millions passed for about 10 days. On 5th could have captured hundreds per hour. Wind variable and light. Weather sunny with occasional showers. Flying at ground level up to 30 or 40 feet. Many very worn. Adkin (Williams 1935d).

1934, Feb. 6–March, mid. Amani, Tanganyika. To S.

Small migration on 6th, increased to "rush" on 20th. After 28th decreased rather suddenly and only stragglers up to mid-March. Direction a few degrees E. of S. instead of more usual S.E. At peak 40 per minute on 15 yards front. Moreau (Williams 1935d).

1934, Feb. 11–15. Nairobi, Kenya. ? To or from S.S.W.

Flight in same direction as wind, "S.S.W.", but not clear if this is "to" or "from." R.A.S. (Williams 1935d).

1934, Feb. Londiani, Kenya. To N.W. or N.N.W.

Passing for a few days before 15th Feb.; on this day increased greatly in numbers. Wind N. in morning, changing to S.W. or W. in afternoon. Weather very dry. Thunderstorm and first rain for a month on evening of 14th. Maximum flight 15–18th. Graham (Williams 1935d).

1934, Feb. Meru, Tanganyika.

Flight as dense as a blinding snowstorm (M. E. Fountaine mss.).

1934, March 1–5. Johannesburg, Transvaal. To N.

Large migration. Traced on 5th as far as Nylstrom about 250 miles to north (J. S. Pringle mss.).

1934, Nov. 21 and Dec. 26. Graaf-Reinet, Cape Province. To N.E.

On 21st Nov. large numbers 7 a.m. in early morning, but all gone by midday. Very hot; wind strong N.W. A few seen in afternoon and stragglers in following week. Flight again noticeable on 26th December. Taylor (Williams 1935d).

1935, Nov. 18. Barberton, Natal. To S.W. or W.

Flight from about 10 a.m. to dusk. At house of observer flight to S.W., but at farm some distance away and round a bend in the hills direction to W. Slight breeze from N.E. 33 females and 21 males sent. Marshall and Pearson (Williams 1936a).

1936, March 5. Sudan. To W.

Large swarm drifting slowly to W. between Karma (lat. 13° 37′ and long. 24° 18′) and Om (lat. 13° 38′ and long. 24° 35′) on the Fasher–Kelkebia road. J. B. Cowland (Williams 1939b).

1937, Aug. Nairobi, Kenya. To E.

Thin migration with *C. florella* and *B. severina*. Rogers (Williams 1939b).

1937, Oct. 23–25. Trans-Nzoia, Kenya. To E.

Thousands in each morning. Wind strong from E. except on part of last day, when strong from W. On 25th, 65 per minute passing 50 yards front (Stoneham mss.).

1937, Oct., end. Thompson Falls, Rumarruti, Kenya. To S.

Millions passed in constant stream over front of many miles, reported by Conservator of Forests. Flying, according to newspapers, against a strong S. wind (T. W. Kirkpatrick mss.).

1937, Nov. 30. N.W. of Lake Victoria, Uganda. To E.

Thousands flying between Mahendi and Mityana. Wind N.E., force 2 (C. Longfield mss.).

1938, Feb. 2–17. Trans-Nzoia, Kenya. To E.

Generally hundreds passing, but thousands between 14th and 16th. Wind strong E. on 2nd and 3rd. Flying close to ground. Weather hot and dry (Stoneham mss.).

1938, Feb. 6–9. Amani, Tanganyika. To E.

Definite migration, winds light and variable, chiefly from N.E. (R. E. Moreau mss.).

1938, Feb. 10–17. Mt. Elgon, Kitale, Kenya. To S.E.

On 10th, 6–8 in sight at once. Weather dry, wind strong from W., which is unusual in dry weather. Flying 3–6 feet from ground. Locality 6700 feet above sea-level. On 11th January observer went 17 miles to east but no flight seen off slopes of mountain. Getting fewer till 17th, flight less definite and more to S. Wind gradually returned to more usual N.E. (E. M. Tweedie mss.).

1938, Feb. 15–19. N. side of Kilimanjaro, Kenya. To W.N.W.

On 15th marked migration at Engari-Rongaii (6500 feet), wind light N.E. On 16th intermittent but at times copious migration over trees of forest belt 6500–8000 feet, and over heatherland at 8000, when very large numbers resting in sheltered places. Steady N.E. breeze all day. Between 17th and 19th Feb. each day slight but definite migration 8000–11,000 feet. Wind light N.E. (Moreau mss.).

1938, Nov. 27. Off Gambia Coast, W. Africa.

Flight seen from steamer 50 miles off Gambia Coast. Three captured (1 male and 2 females). In lat. 13° 27′ N., long. 17° 36′ W. (W. F. Palmer mss.).

1938, Dec. 2. At sea off Cape Verde, W. Africa.

Small numbers came on board ship 6–7 p.m. Ship had passed 2–3 miles off Cape Verde at noon going south. 2 captured (S. F. Clay mss.).

1938, Dec. 10. At sea off Dakar, W. Africa. ? To S.

Hundreds of white butterflies seen from noon to 3 p.m. Ship arrived at Dakar at 6 p.m. Butterflies flying S. Wind from N. Always 2–3 butterflies in sight. 3–20 feet above sea. Weather overcast and rather cool (M. F. Meiklejohn mss.).

1939, mid-Jan. Louisvale, Bechuanaland.

Sudden influx of white butterflies which appeared to arrive during the night and disappear next day, about three weeks before 5th February. Similar invasions noticed previously when they appear to come with a strong E. or N.E. wind. 4 specimens captured (B. T. Mennell).

1939, March 2–11. Amani, Tanganyika. To E. and N.E.

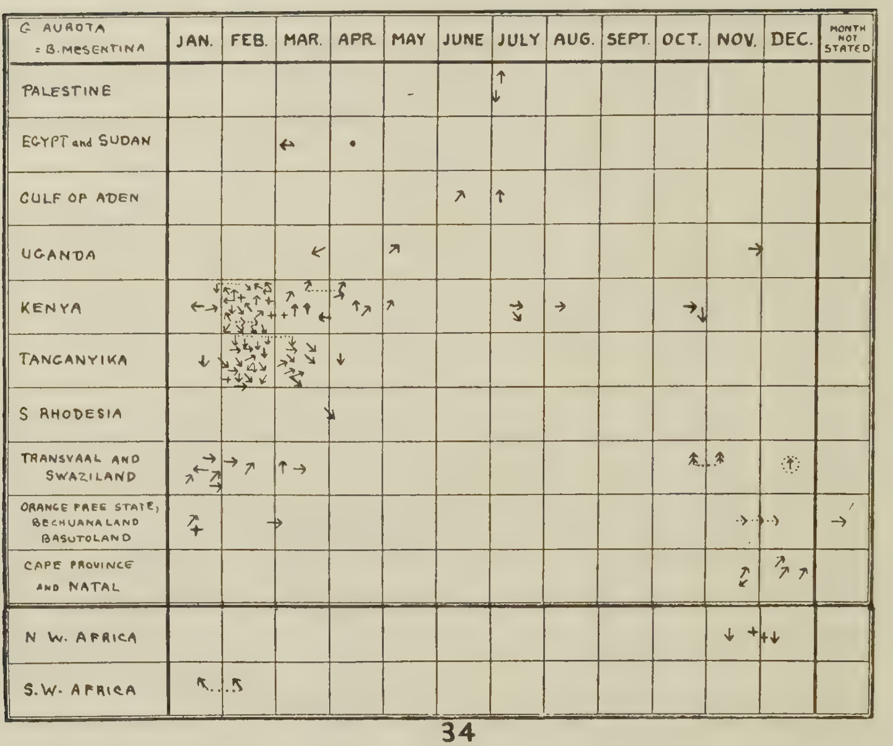
On 2nd marked migration to E. and N.E. On 3rd migration slight, wind N.E.; 4–10th very few; 11th rather more, wind very strong N.E., direction rather more northerly. 24 captured (R. E. Moreau mss.).

1940, March 22–27. Entebbe District, Uganda. To W.S.W.

Seen from Entebbe to Luzura and to Mawokoto border, also through Mengo and to Bugerera. Extreme line from Bugerera to Mawoke is about 140 miles. Continued each day from 7.30 a.m. to 6.30 p.m. At Luzira on 23rd, 21 per minute passing on 22-foot front. Were seen crossing the Nile from the eastern provinces in the Bugerere district. 39 males and 10 females captured (C. W. Chorley mss.).

In addition to the above records Mr. J. Peniston writes that he has seen migrations of white butterflies on three occasions at Weenen, Natal, always to the N.E. Also Hemming writes (1939, *Entomologist* **67** : 135) that in Palestine the species is most common from August to November but that fresh specimens have been recorded in January (at Tabgha and at Jericho) and worn ones at Beersheba in April.

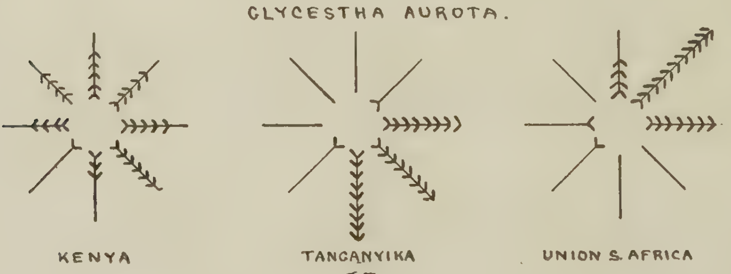
The above observations, together with those already summarised, give a total of nearly one hundred records. These are shown diagrammatically in


G. AUROTA = B. MESENTINA
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
MONTH NOT STATED
PALESTINE
EGYPT and SUDAN
GULF OF ADEN
UGANDA
KENYA
TANGANYIKA
S RHODESIA
TRANSVAAL AND SWAZILAND
ORANGE FREE STATE, BECHUANALAND BASUTOLAND
CAPE PROVINCE AND NATAL
N. W. AFRICA
S.W. AFRICA

34

Fig. 34.—Diagram of recorded flights of *Glycestha aurota* (= *Belenois mesentina*) in Africa.

fig. 34. From this it will be seen that the great majority of records are in Kenya and Tanganyika and in the months of February and March. In these two countries there are very few records at any other time of the year. In the southern portion of the continent the flights have been most frequently recorded in Natal and Cape Province in November and December, but in the Orange Free State and Transvaal etc., they are distinctly later in January to March.


GLYCESTHA AUROTA.
KENYA
TANGANYIKA
UNION S. AFRICA

35

Fig. 35.—Diagram showing flight directions of *G. aurota* in three different areas in Africa.

The few records in West Africa, in Gambia and off this coast are all in November and December.

The direction of the recorded flights in each of the three areas, Kenya, Tanganyika (almost all records in the N.E.) and the Union of South Africa are shown in fig. 35. From this it will be seen that in South Africa the flights are definitely towards the N.E. and in Tanganyika towards the S.E.; but in Kenya there is no prevailing direction.

It would appear that there is a source of migration somewhere in the south-west of South Africa whence come their flights, and that the flights in N.E. Tanganyika originate to the N.W. in Kenya; but the source of the Kenya flights is not definitely indicated. Pitman (1928, *Proc. ent. Soc. Lond.* **3** : 45) has suggested that they originate in the Western Nile Provinces of Uganda, where, in 1928, he found the food-plant (Capparidaceae) abundant and defoliated by caterpillars of this butterfly over large areas. No migration was, however, noticed to be proceeding from here in spite of the vast numbers of butterflies present.

If this were the main source one would expect the flights in Kenya to show a more definite south-easterly or easterly trend.

(7) *Glycestha creona* (= *Belenois severina*).

The following are new records since my last summary (Williams 1930b).

1930, April 5–8. Karonga, Nyasaland. To S.E.

Passing for four days, 2 males, 2 females captured. Lilford (Williams 1933b).

1932, April 29–May 11. Mt. Elgon, Kenya. To N.E.

Occasional on most days, very thick on 6th May, steady stream on 7th, wind when recorded from N.E. slight to strong, females commoner than males (Moysey 1932).

1932, mid-April to beginning of May. Londiani, Kenya. To E.N.E.

A flight of *G. aurota* had been noted 8th–11th April (*q.v.*) and appeared to continue without break, but on 17th April 22 specimens captured were all *creona* (10 females and 12 males). On 17th wind from N.N.E. Flight continued spasmodically during rest of April. On 2nd May about 4000 per hour crossing 30 yards front. Graham (Williams 1933b).

1932, Sept. 7–8. Diafarabé, French Sudan. To W.S.W.

On 7th at noon flying along N. bank of River Niger. Wind fresh S.S.E., force 4, over by 4 p.m., many stopped to settle in flowers of tree, *Parkinsonia aculeata*. On 8th only slight flight, wind S.W., force 2–3; later same day dense swarm of locust passed to E. (O. B. Lean mss.).

1937, Aug. Nairobi, Kenya. To E.

Thin migration with *C. florella* and *B. mesentina* (K. St. A. Rogers mss.).

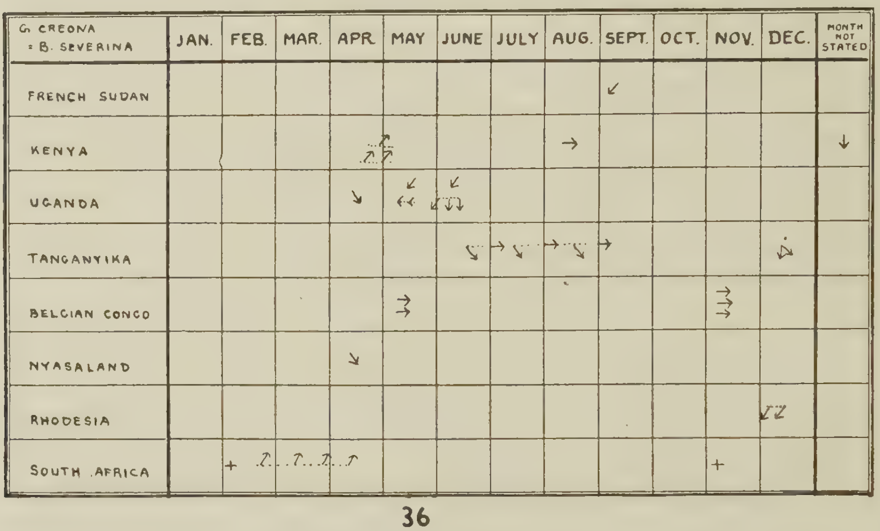
Dr. C. Seydel writes that he has seen this species migrating from W. to E. at Elisabethville, Belgian Congo, in May and November nearly every year. It is said there to feed on *Cereopetalum dasyanthum.*

This insect is a much less definite migrant than the previous species *Glycestha aurota*, but is frequently mistaken for it in flight and with many of the records of " White butterflies " in East Africa it is impossible to say which species was concerned.

It will be seen, however, from fig. 36, which contains all the known records which are definitely this species, that the time of flight in East Africa is distinctly different from that of *G. aurota.* The latter (fig. 34) started about the end of December and died away about April, whereas this species has most of its flights in East Africa in May and June with one flight in Tanganyika extending through July and August. This species also extends across into the Belgian

Congo, where there are several records of flight, but does not reach so far north in N. or E. Africa as does the previous species.

One of the more interesting records is that of April 1932 at Londiani, Kenya; Mr. Graham had noted a flight of white butterflies in the early part of the month (8th–11th) and had sent specimens all of which were *G. aurota.* About a week later (on the 17th), during which period the flight had not ceased, a number of specimens sent were all *G. creona.*



36

FIG. 36.—Diagram of recorded flights of *Glycestha creona* (= *Belenois severina*) in Africa.

These two butterflies make an interesting example of the necessity of careful identification in the field, and of the need of getting a number of specimens at intervals during the same flight.

(8) *Glycestha* (*Belenois*) *java teutonia.*

Glycestha java is the only "white" butterfly of which I have definite records of migration in Australia. On several occasions statements have been made suggesting that some species of *Delias*, possibly *D. nigrina* or *D. harpalyce*, also migrate, but in spite of many enquiries I have been unable to get any confirmation in the form of actual specimens caught during a migration.

In my previous summary (Williams 1930b) I was able to give about a dozen records of flight of *G. java* and the following are additions to this list.

1882, Feb.–April. Nr. Rockhampton, Queensland.

B. teutonia and *Catopsilia pomona* literally swarmed for a time and for a few days fell like snow in streets of Rockhampton (G. Barnard 1883).

1886–7, summer. Melbourne, Victoria.

Simply swarmed in the district (Lucas 1887).

1920–21, Dec.–Jan. Glass-house Mts., Queensland.

Puxley (n.d.) repeats the account previously quoted (Williams 1930b) but gives the date as December or January instead of September.

About 1921. Near Brisbane, Queensland. To S.

One day, about fifteen years before 1936, clouds flew over Stradbroke Island, about 20 miles S. of Brisbane, in close formation (Wilkinson mss.).

? 1933. Morea, N.S. Wales. To N.W.

Countless thousands seen by Mr. A. Musgrave. Found breeding in great numbers on wild orange and wild pomegranate (newspaper report).

1934, ? Dec. Coldstream, nr. Melbourne, Victoria. To E.

Thousands passed over farm, some settling (newspaper report).

1935, about January. Sydney, N.S.W. To E.

Millions flying through town and out to sea. Flying low near ground. Irvine (Williams 1936a).

1935–36, summer. Southern Victoria. To S.

Myriads flying, very abundant on Phillip Island, Western Port Bay, as well as on mainland (C. Barrett mss.).

1937, end Jan. or beginning Feb. Sydney, Australia. Approx. to N.

Flight for two days, but less dense on second; observed at Lane Cove River, about 4 miles N.W. of Sydney. Flight chiefly 2–3 feet above ground, rose vertically over buildings and descended again into a quadrangle; about 70 per minute on 90-foot front at 2–3 p.m. and over 100 per min. on 85-foot front between 4 and 5 p.m. (N. Burke-Gaffney mss.).

1938, Jan.–Feb. Edgecliff, Sydney. To N.E.

First specimen, a male, seen on 1st January. On 10th January, thin migration, 310 females and 519 males passed through gap in hedge in 3 hours, all to N.E.; flew from garden out over water at Rose Bay. Flying 2–8 feet about ground. Following day only a few stragglers. On 17th, 25th and 27th January and 12th February very occasional males seen passing to N.E. On 29th March about 10 males seen passing to N.E. (A. D. M. Busby mss.).

1938, Nov. Sydney.

Thousands of small white butterflies have invaded the coast round Sydney, drifting with the wind (Sydney newspaper of 11th November 1938).

1938, Nov. 9–11. Sydney. To N.

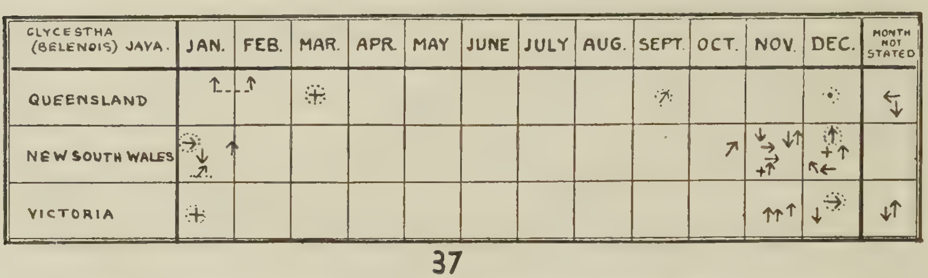
On 9th November a boat crew on river was " greatly incommoded " by thousands of butterflies : wind a little W. of N., force 1. Temp. 87° F. On 10th flight continued. Thirty butterflies seen round one bush : speed about 6 m.p.h., temp. 97° F., wind almost W., force 3 : many seen sleeping in pine trees in evening. On 11th at 9 a.m. 20 individuals timed over measured 200 feet with stop-watch : speed varied from 4 to 10 m.p.h. with average just over 8; wind S., force 1 : flying 2–20 feet from ground, majority about 6. Numbers crossing 100 feet of hedge average 20 per min. for 15 minutes. At 10 a.m. 500 passed in 15 minutes on a 180-foot front. Ten tests for speed at this hour gave 6½ m.p.h. Only few stragglers left at 2 p.m. On 12th many about but not moving in any definite direction (N. Burke-Gaffney mss.).

1939, Nov. and Dec. Sydney. To N., N.N.E. and W.

On 15th November one male flying to north. On 3rd December 10 to 15, mostly males, flying to N.N.W. about 5–10 feet from ground. On 11th December small flight in morning for about 2 hours, about 15 feet above ground. Rather denser flight for about 3 hours in afternoon. To N.N.W. On 14th December very thick flight, thousands and thousands, flying to west (unusual direction). Wind light from E. but not enough to affect butterflies. Valerian in garden weighed down with butterflies settling on it. First noted 8 a.m., all gone by noon. Thirteen males and 2 females captured (A. D. M. Busby mss.).

In addition to the above records, which are more or less definitely *Belenois java*, Mr. A. D. M. Busby gave me the following notes on a flight of white butterflies that he saw in the Yarraman Valley, Liverpool Range, N.S. Wales, in December 1907, all flying from south to north.

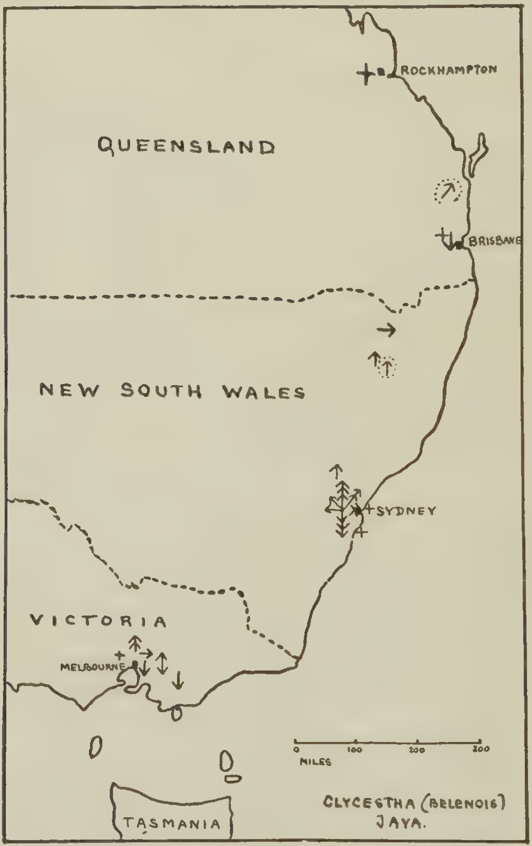
Large numbers of butterflies with black tips to wings and marked beneath with red and yellow were migrating. The flight was about 3 miles wide and outside this there were no butterflies. The edge of the flight was so definite that although large numbers were passing through the front of his house, which was on one edge of the flight, none could been seen at the back of the house. The butterflies were flying from about 3 to 20 feet above the ground. They were first seen at sunrise, rested at midday and resumed again at 2 p.m. till sundown, when they rested for the night. One Jasmine shrub in the garden was drooping with the weight of the butterflies settled on it. On the following day millions were in the air at sunrise; during the day the numbers reached 30–40 per square yard. Again they rested at midday and resumed their flight, almost simultaneously at 2 p.m. On the third day there were fewer and on the fourth only stragglers. Mr. Busby notes that the ordinary common field butterflies seemed to be greatly bewildered by the flight and hid themselves in the crops and grass during most of the migration.


GLYCESTHA (BELENOIS) JAVA.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
MONTH NOT STATED
QUEENSLAND
NEW SOUTH WALES
VICTORIA

37

Fig. 37.—Diagram of recorded flights of *Glycestha* (*Belenois*) *java* in Australia.

About 80% of the butterflies were whitish with a darker margin above, and about 15% with much more black above. In addition Mr. Busby recollects red and yellow markings beneath. These were undoubtedly male and female


ROCKHAMPTON
QUEENSLAND
BRISBANE
NEW SOUTH WALES
SYDNEY
VICTORIA
MELBOURNE
0
100
200
300
MILES
TASMANIA
GLYCESTHA (BELENOIS) JAVA.

38

Fig. 38.—Map showing recorded flights of *G. java* in Australia.

of a Pierid, but it is not possible to say definitely if it was *Belenois java* or a species of *Delias*. Mr. Busby (see above) has since seen *B. java* migrating in Sydney but he thinks that the Liverpool Range butterflies were rather larger.

In the flight also were about 5% of a "swallow tail," which appears from a sketch made at the time to be *Papilio aegeus*, a species that has not previously been recorded as a migrant.

Alexander (1917) records that *java* became suddenly abundant in the neighbourhood of Perth, S.W. Australia, in the summer of 1914–1915, together with *Papilio demoleus sthenelus*, *Terias smilax* (first time recorded in the S.W.) and incredible numbers of *Danaida chrysippus petilia*. This is the first indication of migration of any Lepidoptera in the western half of Australia.

Fig. 37 shows diagrammatically all the recorded directional flights of *G. java* in Australia arranged according to the month in which they occurred. It will be seen that the majority are in November, December and January. The only records between March and September are doubtful, and in fact, the "September" record by Puxley, was in a later account given as "December or January." The period of flight corresponds with the spring season in that part of the world.

Fig. 38 shows the distribution of the flights geographically and one immediately sees the number of records concentrated round the large towns, due to the greater chance of the presence of an interested observer. From the most southerly record in Tasmania to the most northerly at Rockhampton the distance is about 1200 miles.

(9) *Catopsilia florella.*

The following records are not included in my 1930 summary for this species.

1925. Stanleyville, Belgian Congo.

Unusually abundant at the beginning of the "strong" rains, but not moving. Ghesquière (1932 : 301).

1929, Aug. Kadaru, N. of Khartoum, Sudan.

About 50 acres of Senna (*Cassia* sp.) severely damaged by larvae of *C. florella*. Bedford (1930, *Sudan Ent. Bull.* **31** : 38).

1932, Jan. 28. Londiani, Kenya. To E.N.E.

With *B. mesentina* and others in small flight against a fairly steady wind. Graham (Williams 1933b).

1932, April 17. Londiani, Kenya. To N.N.E.

One sent from a migration of *B. severina*. Graham (Williams 1933b).

1932, June 3–10. Kiminini, Mt. Elgon, Kenya. To S.W. or S.

On 3rd steady flight to S.W.; no wind; 24 in 15 minutes on a 30-yard front. On 4th June to S.W. or S., no wind. On 6th June wind N.E. flight S. From 7th–10th June irregular flow about 1 per minute continued. Moysey (Williams 1933b).

1933, March and April. Londiani, Kenya. To N.N.E.

A few in migration of *B. mesentina*. Graham (Williams 1935d).

1934, Jan. 3–end. Londiani, Kenya. To N.W. and N.N.W.

On 8th up to 10 on area 30 yards square. Flying fast but a few stopped to feed. Wind steady from N.E. Some rain E. of Londiani but none there. Note that direction of flight is unusual. Graham (Williams 1935d).

1934, March 7–9. Gatooma, S. Rhodesia. To E.

Large number passing high overhead. Reported also 20 miles away. Continued for 3 days, when heavy rainstorm in evening. Next day none. Many other species included in flight. Houston (Williams 1939b).

1934, May 29–June 2. Amani, Tanganyika. To slightly W. of S.

About 10 per min. passing on 100-yard front, with very rapid flight. Moreau (Williams 1935d).

1934, Dec. 24–28. Amani, Tanganyika. To S.E.

Definite migration reported. N.E. wind had started. Flights at this time of year usually to N. Moreau (Williams 1935d).

1935, Jan. 8–17. N.E. Tanganyika. To N.
Flight across Ngorongoro Crater on 8th, a few points W. of N. descending the steep sides of the crater to the bottom. Also strong at Mbulu from 12th–17th, steady and often strong N.E. wind blowing day after day. Moreau (Williams 1935d).

1935, Feb. 6–10. Amani, Tanganyika. To N.
On 10th migration seen from Amani for about 10 miles towards the coast, but not nearer coast than this. Wind strong gusty S.E. Moreau (Williams 1935d).

1935, April 9. Barberton, S. Africa. To E. or N.E.
Steady flight against " fresh breeze," of about 20 m.p.h.; 63 seen in 45 min., of which 32 to East. Marshall (Williams 1936a).

1935, Dec. 26–29. Gatooma, S. Rhodesia. To S.E.
Singly or in pairs all day. Against E. or S.E. wind of 1–3 force, fine and bright, flying low. Last rain on 21st December. Peat (Williams 1939b).

1936, April 17. Off Aden. (N.)
One seen about 30 miles E.S.E. of Aden (Moreau mss.).

1936, —. Salisbury, S. Rhodesia. To N.
Seen in flight of *B. gidica* (Cuthbertson mss.).

1936, Nov. 3–4. Lundari, N. Rhodesia. To E.
Numerous all day. Winterbottom (Williams 1939b).

1936, Nov. 13. Nr. Gatooma, S. Rhodesia. To W.
Flying strongly between Gatooma and Umsweswe, just above ground—widely spaced 10 a.m. to evening. Wind very slight. Rainy season just commenced. Houston (Williams 1939b).

1936, Nov. 29. Fort Jameson, N. Rhodesia. To W.
Winterbottom (Williams 1939b).

1936, Dec. 22–Jan. 6, 1937. Umsweswe, S. Rhodesia. To S.E.
On 22nd hundreds flying low with light breeze. On 23rd and 27th greatly increased numbers, then steady decrease. A few only on 6th. Houston (Williams 1939b).

1936, Dec. 26. Fort Jameson, N. Rhodesia. To W.
Weather hot. Winterbottom (Williams 1939b).

1937, Feb. 7–18. Barberton, Natal. To N. and E.
Gradually more abundant. On 18th 207 in 15 minutes with 93 to N., 23 to N.E. and 33 to E. Wind gentle E. Marshall (Williams 1939b).

1937, March 22–24. Springs, Transvaal.
Appeared in hundreds with many *D. chrysippus*. All gone a few days later, but no directional movement noted. *C. florella* not known to breed in this area (Murray mss.).

1937, Aug. Nairobi, Kenya. To E.
In thin migration with *B. mesentina* and *severina*. Rogers (Williams 1939b).

1937, Dec. 17–25. Fort Jameson, N. Rhodesia. To E.N.E. and N.E.
On 17th at Fort Jameson in ones and twos heading N.N.E. almost directly into stiff breeze 9 a.m.–4 p.m., all within few feet of ground. On 19th denser and to N.E. till 2 p.m., when heavy storm (Winterbottom mss.).

1938, Jan. 14–15. Trans-Nzoia, Kenya. To W.
Scores passing 10 a.m.–2 p.m. 6–7 feet above ground. Wind light easterly (Stoneham mss.).

1938, Dec. 30–Jan. 15, 1939. S.W. Uganda. To N.
Steady movement over lakes Mutanda and Mulehe throughout the day. Wind steady from N.W. and N.E. Always at least six in sight on lake (Pitman mss.).

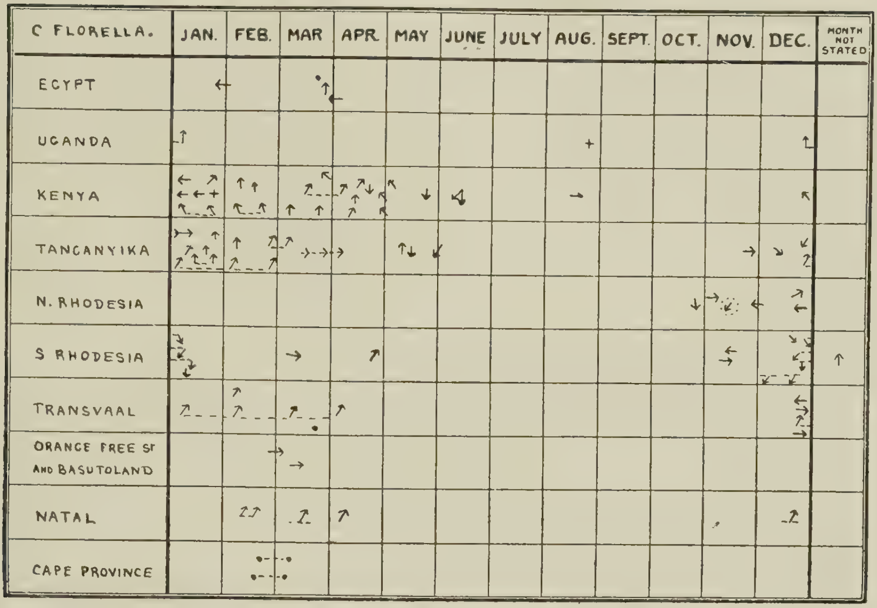
1939, April, end. Salisbury, S. Rhodesia. To N.E.
Passing in small numbers in last week in April (Cuthbertson mss.).

Fig. 39 shows diagrammatically the recorded flights according to country and the month of the year.

It will be seen that most of the records are in Kenya and Tanganyika from the end of December to the end of April, with a few in May and June. Farther south the period without flights lengthens and in Transvaal, Natal and the Cape Province there are no flights from mid-April till the end of December.

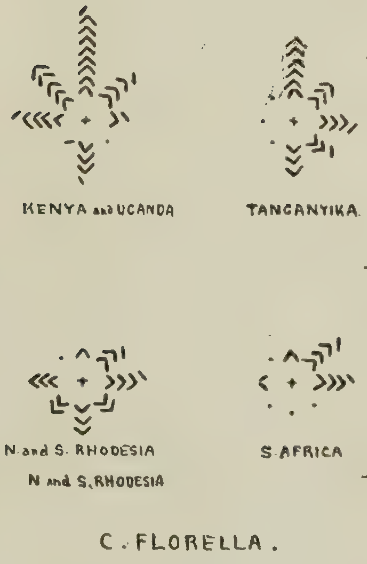
In Northern and Southern Rhodesia the flights seem to start earlier in November.

Fig. 40 shows rosettes of the recorded flights for each main area. In Kenya and Uganda the majority are to the N. and N.W. In Tanganyika there are flights to N.E. and S., but none to the W. In N. and S. Rhodesia there are


C FLORELLA.
JAN.
FEB.
MAR
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
MONTH NOT STATED
EGYPT
UGANDA
KENYA
TANGANYIKA
N. RHODESIA
S RHODESIA
TRANSVAAL
ORANGE FREE ST AND BASUTOLAND
NATAL
CAPE PROVINCE

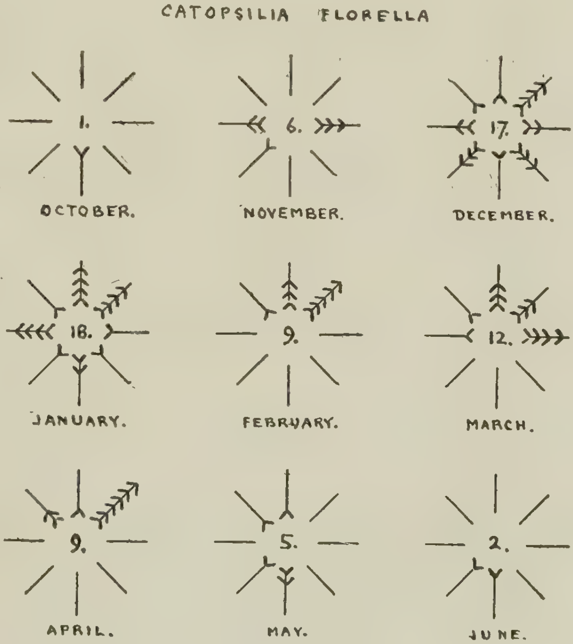
39

Fig. 39.—Diagram of recorded flights of *Catopsilia florella* in Africa.


KENYA and UGANDA
TANGANYIKA.
N and S. RHODESIA
S AFRICA
N and S. RHODESIA
C. FLORELLA.

40

Fig. 40.—Directions of flights of *C. florella* in different parts of Africa.


CATOPSILIA FLORELLA
1.
OCTOBER.
6.
NOVEMBER.
17.
DECEMBER.
18.
JANUARY.
9.
FEBRUARY.
12.
MARCH.
9.
APRIL.
5.
MAY.
2.
JUNE.

41

Fig. 41.—Direction of flights of *C. florella* in Africa in different months of the year.

practically no flights to the N. and N.W. (cf. Kenya and Uganda), while in S. Africa nearly all the flights are to the E. and N.E. It is difficult at the present state of our knowledge to suggest any explanation of these curious differences.

Fig. 41 shows the flights arranged according to the month. The majority are from November to April. It is interesting to note that there are no flights recorded with a southerly component during February, March and April. This may be accidental, and more records are needed from all areas before definite conclusions can be drawn.

(10) *Andronymus neander.*

New Records.

1926, March or April. Amani, Tanganyika. ?.
Big migration flying " in usual direction " (Burt mss.).

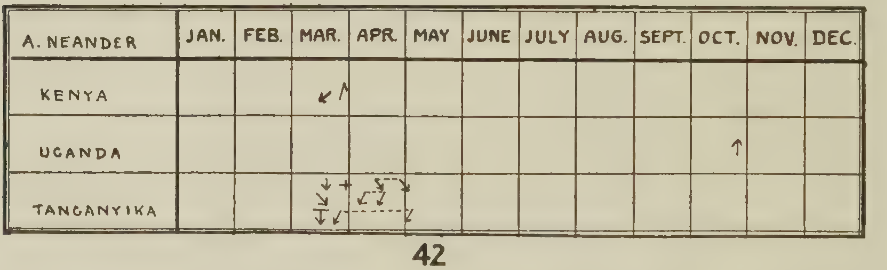
1930, March. Malindi, nr. Mombasa, Kenya. To W. by S.
Many hundreds flying more or less down the coast 8–15 feet above ground. Flying swiftly for some hours, little or no wind; about 5 p.m. smaller numbers flying in opposite direction, though still some flew in original direction. Two specimens captured. Graham (Williams 1933b).

1931, Oct. 28. Makimuga, Bwambo, Uganda. To N.
Large swarm flying at average height of 20 feet for one hour, one captured. Hazel (Williams 1933b).

1937, March. Amani, Tanganyika. To S.
Very dense migration for a week or more, 5–10 feet above ground (Nutman mss.).

1939, April. Amani, Tanganyika. To S.E.
Up to 200 per minute in narrow lanes of flight. Forty-two specimens captured (Kirkpatrick mss.).

The above new records together with those already published (Williams 1930b) indicate the very definite movement in March and April through Amani in N.E. Tanganyika, which has already been reported in eight years and probably occurs in most. However, in 1929 when I was in Amani until the 8th April, no trace of a movement had been observed up to that date in spite of a very close watch. The recorded flights are shown diagrammatically in fig. 42. The only flight in March and April that is not towards the southerly quarter consisted of only a few individuals in a flight of other species; the only flight at another period of the year, in October, is towards the north.



42

FIG. 42.—Diagram of recorded flights of *Andronymus neander* in East Africa.

(11) Subfamily ACRAEINAE.

In my previous summary only two species of this subfamily had been recorded as doubtful migrants; *Acraea violae*, which had twice been seen in small numbers taking part in mixed flights of other species in Ceylon; and *A. andromacha*, which had once been recorded in a flight in Queensland.

The ACRAEINAE have neither the habits nor the type of flight that one would associate with long-distance migration but several new records from Africa have now been received that put the occurrence of directional flights in the group beyond doubt, although it is not yet known over what distances they continue. The following records are new.

(1) W. Houston reported (Williams 1939b) that species of *Acraea* were taking part in a large mixed flight of many species that were moving to the east at Gatooma, Southern Rhodesia, on 7th–9th March 1934. The species were chiefly "Whites and Yellows" (including *C. florella*) with Danaines, *Atella phalantha* and others.

(2) In October 1937 at Trans-Nzoia, Kenya, Lt.-Col. Stoneham reported that *Acraea caldarena* and *A. disjuncta* were migrating in large numbers.

During the period 6th–13th October *A. caldarena* was passing in small numbers always towards the north. They were very swift on the wing and difficult to catch, although flying close to the ground. Specimens of both sexes were captured.

A. disjuncta was moving at the same time but in much larger numbers; "thousands" on the 7th, "hundreds" on the 8th, smaller numbers on the 9th and "hundreds" again on the 10th and 11th, and about 20 on the 13th. The flight direction was less constant, some days to the north and others to the west. The flight was leisurely, some low down and others high over trees. Both sexes were present.

The wind was strong from the north on the 9th, calm on the 10th and 13th and variable on the other days.

(3) A flight at about the same time was observed by Mrs. M. Tweedie at the Caves of Elgon, Kitale, Kenya. She observed a flight in mid-October 1937; not thick, but one day there were always 3–4 in sight moving steadily to the N.E. against the wind. One specimen was sent which was identified at the Natural History Museum as *Acraea jodutta*. Mrs. Tweedie adds that she had never noticed this species in the district before or after the flight.

(4) Mr. C. W. Chorley observed two flights of *Acraea bonasia*, *A. acerata* and *A. terpsichore* in S.W. Uganda in March 1940. The first flight was seen on the 14th March at Duma Point, Mawokota, Masumka District, on the west shores of Lake Victoria. The butterflies were coming across the lake from the Sesse district, flying towards the west, a distance of about 28 miles of open water. According to local fishermen they had been passing for two days in countless thousands.

On returning to the Luziro, Kyadondo, Mengo district, about 90 miles from the previous locality, he observed another migration also towards the west, which was also said to have been in progress for two days. Between the two localities no movement was noticed. A number of specimens were sent to Prof. G. D. H. Carpenter, who identified them as above.

(5) Stoneham (1934) records as migrants *Acraea melanoxantha* (in my reprint changed in mss. by the author to *oreas*) occasional; *A. terpsichore* not frequent; *A. caecilia* a strong migrant some years; *A. caldarena* very strong but irregular migrant; *A. egina* local; *A. asboloplintha* local; *A. neobule* a strong migrant some years; and *A. pharsalus* some years; but no details are given of any records in support of the above statements.

VII. EXPERIMENTS IN MARKING BUTTERFLIES.

By G. F. COCKBILL.

It has been realised by many workers that if migrant butterflies were suitably marked at some point on their route, and recaptured at some other point, much useful information would be forthcoming as to direction and speed of flight. Such marking experiments have been carried out with success with migrant birds, but, as yet, little progress has been made in the case of insects.

Marking experiments can yield two distinct kinds of evidence. If insects are marked and subsequently recovered at a distance from the locality of liberation, there is direct evidence of speed and direction of flight. This information is the most valuable, but the most difficult to obtain. The only case of a recovery at a distance known to the writer is that of a *V. atalanta*, marked at Stroud, Glos., by T. B. Fletcher and later believed to have been seen again at Reading, Berks. However, the observer could not get near enough to see the identification number of the insect. (Fletcher *in litt.*)

Information can also be obtained by noting the rates at which marked individuals of different species disappear from a locality. It is assumed that migrant species move away from a locality more rapidly than do non-migrants.

It is necessary to devise a method of marking the insect in such a way as to render it very noticeable, and to provide an identification number together with a well-known address to which information concerning recapture can be sent. The marking should be carried out on a large scale by a team of workers in areas where migrant species are most frequently and abundantly observed, and collectors should operate in areas situated concentrically around the area of marking.

Previous methods of marking Lepidoptera.

Various methods of marking have been used. Meder (1926) used a 0·8% alcoholic solution of ruby and scarlet dyes with a little shellac added. He marked the upper surface of the fore-wing with spots to denote the date of liberation and the under surface of the hind-wing with a mark to identify the locality of liberation. Of four to five thousand Pierid butterflies marked and liberated in July 1925, only five were recovered: four at Kiel and one at Lübeck.

Collins and Potts (1932) used aniline dyes mixed with 70% alcohol, and also artist's paints thinned with petrol, applied by means of a camel-hair brush for marking male Gipsy moths, *Lymantria dispar* L., when investigating the rate of spread of the pest in the U.S.A.

O. Querci (1936) records that in December 1929 at Cristo, near Santiago of Cuba, he marked a large number of butterflies by clipping their wings in various ways to verify that some underwent aestivation. He obtained recoveries as long after marking as June and August of the following year.

T. B. Fletcher (1936) attached small labels to the wings of butterflies by means of Canada Balsam, after removing a small patch of scales. His method of labelling was to use R for Rodborough, Stroud, Glos., England, where the insects were marked, and a series number to identify the specimen. He kept a descriptive record of each insect he marked.

During the season 1936 he marked 75 butterflies. One *V. cardui* remained at Rodborough for 10 days after marking, six *V. atalanta* for 2 or 3 days, one for 7 days and one for 12 days.

In 1938, he continued marking *V. atalanta.* His results are summarised later (p. 224).

In 1936, at Rothamsted Experimental Station, Mrs. K. Grant marked over 300 *V. urticae* by means of spots of coloured enamel paints placed on different parts of the insect. She reserved a special mark for each day when marking took place, but used no distinguishing mark for each insect.

Mr. D. A. Christianson of Hinckley, Minnesota, writes that during 1936 and 1937 he had marked 208 butterflies, mostly Monarchs, with serial numbers. His method was to attach to the thorax a thin cellophane label having a serial number, together with his box number and address. He says that the printing on the label was " so small as to be scarcely legible." He attached the labels by coating them with the adhesive from zinc oxide plaster.

Later he improved on his method by using as labels thin strips of metal foil in various bright colours. He was able to print on these labels in waterproof Indian Ink, or to die-stamp them. His method might be of use with the larger butterflies such as the Monarch, but we found on experiment at Rothamsted that the metal foil interfered with the flight of butterflies even as large as the Cabbage Whites.

Spots of coloured cellulose paints, arranged according to a key, were used by G. A. Brett in marking Vanessid butterflies in 1938. Each day had a special mark. He has kindly sent the results of his experiment to Rothamsted for inclusion and they will be discussed later. Here, again, individuals marked on one day were indistinguishable from one another.

W. F. Smith reports that he cut notches in the wings of several Monarch butterflies at Englewood, Fla., and recaptured four, one of which had been marked 11 days previously.

Since this section was written, Urquhart (1941) has described a method he has used in marking Monarch butterflies in Canada. A small hole, about $\frac{3}{16}$ of an inch in diameter, was punched with a paper punch, through the right fore-wing near the base and immediately behind the stout radial vein. The label, made of light paper gummed on one side, was bent over the front margin of the wing and glued to itself through the hole. It took only 15 seconds to punch the hole in this way and apply the label.

A further marking method.

After several tests with various labels and adhesives, the following method was found to be the most suitable for the purpose.

It was the combination of a label bearing a serial identification number and a well-known address attached to one wing with a plainly visible coloured mark on the other wing. It was considered that the address " London Zoo " was the best-known address with a conveniently short title, and the Zoological Society of London kindly agreed to its use and to co-operate in the scheme by sending us any information of recaptures that they might receive.

The address and number were written in waterproof Indian Ink, in mirror writing on labels cut from thin cellophane. The label was smeared on the written side with " Durofix " thinned with amyl acetate, and attached to one fore-wing of the insect. The other fore-wing was marked by applying with a camel-hair brush an alcoholic solution of basic fuchsin for white butterflies, and with a quick-drying white paint for the dark-winged species. An assortment of marks was obtained from the letters of the alphabet or from simple geometric designs, keeping a separate mark for each species on each day. The label and mark dried within a few seconds.

After a little practice it was possible to hold the insect with the first finger over the thorax and the thumb and second finger underneath, so that the wings were outstretched, allowing easy application of the label and mark. If the labels were written beforehand, the marking took only a few seconds for each insect.

After being marked, the insects were liberated, and the time, date, number, identification mark and species were card indexed.

All particulars of any recoveries were noted. During 1939 just over 400 butterflies were marked. Most of the butterflies were liberated at Rothamsted Experimental Station, but some batches were liberated from points situated about 1½ miles due north and due east of the Station on the chance that they would reappear in the neighbourhood of Rothamsted, thereby giving information of speed and direction of flight. However, none of these latter was recaptured.

The results of marking experiments at Rothamsted and elsewhere.

The total number of insects marked at Rothamsted in 1939 was 403, including the species *Pieris brassicae*, *P. rapae*, *P. napi*, *Vanessa io* and *V. urticae*. Of these 403, only 23 or 5% were recovered in the neighbourhood.

Table 25.

Recovery of butterflies marked at Harpenden in 1939.

Species	Total marked	Total recovered		No. recovered after days:							
		No.	%	1	2	3	4	5	6	7	8 and over
P. rapae	254	17	8	5	9	1 + (1)	1	2	0	0	1
P. brassicae	117	1	0·9	0	0	1	0	0	0	0	0
P. napi	23	1	4	0	1	0	0	0	0	0	0
N. io	6	3	50	1	2	0	0	0	0	0	0
A. urticae	3	1	33	0	0	1	0	0	0	0	0

In Table 25 the number and percentage recoveries are indicated, together with the number of recaptures after 1 to 8 days. It will be seen that there were more recoveries of *P. rapae* and *P. napi*, and far more of *V. io*, and *V. urticae* than of *P. brassicae*.

The numbers printed in brackets indicate that there is a doubt about the identity of the specimen (*e.g.* an observer noticed the mark on the insect, but not the number).

The numbers are too small to yield much real information, but if anything is shown, it is that during the experiment *P. brassicae* was moving out of the district more rapidly than *P. rapae*. This experiment, while not intended to demonstrate that *P. brassicae* was migrating, certainly lends support to this view.

Table 26A shows the results obtained by Fletcher in 1938. Here 101 *V. atalanta* were marked, and 25 different insects were recovered, *i.e.* 25%, of which more than half were not seen later than 2 days after marking. There is an indication that the butterflies were moving away from the locality of marking and that marked individuals were constantly replaced by fresh arrivals.

In the same table, the analyses of the experiments of K. Grant (B) and G. Brett (C) respectively are given. It is unfortunate that in both of these there was no provision made for identifying the individual insect. All individuals of a species marked on the same day received the same mark. This omission considerably detracts from the available information, since it leaves it an open question whether subsequent observations of insects on any particular day are to be regarded as being the same insect or as different insects.

Table 26.

Recovery of marked butterflies :—A, by T. B. Fletcher at Stroud in 1938. B, by K. Grant at Harpenden in 1936. C, by G. Brett at Esher in 1938.

Observer and species	Total marked	Recoveries Max. No.	Recoveries Max. %	Recoveries Min. No.	Recoveries Min. %	Recovered after days: 1	2	3	4	5	6	7	8 and over
(A) T. B. Fletcher													
V. atalanta .	101	25	25	25	25	10	6	6	4	4	3	2	6
(B) K. Grant													
A. urticae .	329	115	35	8	2·5	47	26	16	20	13	5	2	2+(1)
(C) G. Brett													
V. atalanta .	141	14	10	8	6	7	0	3	2	0	1	2	3
A. urticae .	77	35	45	13	17	17	9	5	3	0	1	0	3
N. io . .	37	12	32	6	16	7	5	1	1	0	0	0	1
V. cardui .	6	0	—	0	—	—	—	—	—	—	—	—	—
V. c-album .	16	9	64	4	29	2	1	1	2	1	1	1	0

In the case of K. Grant's experiment on marking *V. urticae*, 32 individuals were marked on 14th September 1936 with a yellow paint spot at the base of the right fore-wing. The results show that the numbers and dates of recapture are as follows :—

On September 14th 32 marked.
,, 15th 8 recaptured and released.
,, 16th 8 ,, ,,
,, 17th 6 ,, ,,
,, 18th 5 ,, ,,
,, 19th 3 ,, ,,
,, 20th 2 ,, ,,
,, 22nd 1 ,, ,,

Since there was no distinction made between individuals, the records of recovery on any day may all relate to the same or to different individuals. The " maximum recoveries " would be arrived at by assuming that all records refer to different individuals, while the " minimum recoveries " would be those when it is assumed that only one individual of any batch marked was recovered. Both possibilities are considered in Table 26, where the maximum and minimum number and percentage recovery are shown.

It will be seen that the total recaptures from any batch marked may possibly be equal to, but cannot exceed, the number marked. Any recaptures in excess of the number marked each day have been disregarded in obtaining the "maximum recaptures," but the figures for the "recaptures after 1 to 8 days" include all recaptures. When all recoveries are regarded as being different insects, there are 35% recaptures, but when only one recapture is allowed for any day's marking, the percentage recapture is only 2·5%. The real value lies somewhere between these two, but the range is too great for the results to be of much significance.

This same wide variation between the percentage recaptures is seen in the cases of *A. urticae*, *N. io* and *V. c-album* marked by Brett (Table 26, C).

In the case of *V. atalanta*, however, there were at most only six insects which may have been seen on more than one occasion. The percentage recovery lies between 10% and 6%, and is the lowest of the species concerned.

It is doubtful whether Brett's figures are significant after allowance is made for the possibility of recapturing the same insect more than once, but if anything is shown, it is that *V. atalanta* and *V. cardui* have moved away from the area of marking faster than the other species.

VIII. The problem of orientation.

By C. B. Williams.

The problem of the method by which migrating insects determine the direction of their flights, and keep to a fixed direction over long distances and over long periods of time (sometimes many weeks) still remains unsolved and still remains one of the most fundamental questions in the study of migration.

One would expect some external guiding force or stimulus to be concerned in this direction determination, and so far the most frequently suggested possible stimuli are wind, light and the earth's magnetic field.

It is proposed to discuss the problem from the following point of view :—

(1) Is the structure of the wind such that it would be possible for an insect flying in the current to determine the direction of the wind from perception of pressure alone ?

(2) If this is so, what evidence is there that insects are conscious of and allow for the influence of the wind direction ?

(3) What new evidence is there on the relation of the wind to the direction of the migrating flights ?

(4) Could the orientation be determined by any other method, and in particular by (*a*) sight or (*b*) the magnetic field.

Before entering on a discussion of the "wind" problem it will be interesting to bring forward an observation made by Mr. V. C. Carr on a definite double change in direction in a flight of Monarch butterflies (*D. plexippus*) with no apparent obstacle to account for it, and which appears at present quite inexplicable on any theory.

He writes, "In September 1935 I was fishing in Port Bay, a part of Lake Ontario on the south shore about 50 miles east of Rochester. On looking up I noticed a flight of Monarchs going south, flying about 60 feet above the water and 100 feet from land. A short distance to the south of me they made a sharp left turn, crossed the bay (about a quarter of a mile), then made a right turn and headed south again.

"At no time was there a massed flight nor did they extend over a space of more than 10 to 12 feet in width. At times I would say one or two thousand passed, and again only a hundred or so. Then there would be breaks in the flight for a short time. I anchored my boat under both of the turning points, and turns were made at the same two places all day. The flight stopped about an hour before dusk. The butterflies moved quite fast; I would estimate about 15 miles per hour."

Mr. Carr sent a sketch map of the locality which is reproduced in fig. 43.

The interest of the observation is great but at present it does not seem possible to suggest any reason for the change in direction or how to account for butterflies passing in the late afternoon changing direction at the same spot as those which passed many hours before.

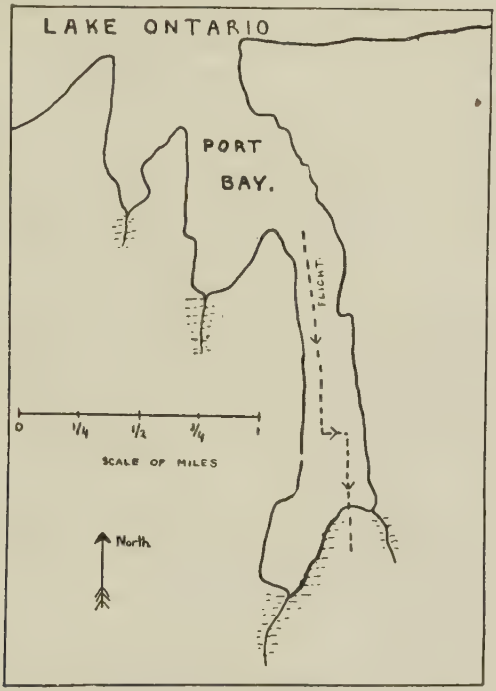


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FIG. 43.—Map of flight of *D. plexippus* in the south of Lake Ontario, with a double change of direction.

Wind structure and its possible effect on orientation and migration.

In my book on migration (Williams 1930 : 382) I discussed the problem of the effect of wind on an insect flying in a moving air current, and to what extent an insect might be able to determine the direction of the wind from the variations in pressure which it feels.

Very briefly, the conclusions I then came to were as follows :—(1) In an absolutely steady wind an insect (or bird) would be unable to determine the direction of the current. This is of theoretical interest only since winds are never steady. (2) In the practical case of an unsteady wind the insect would feel pressure on different parts of its body according to the acceleration (positive or negative) of the wind, because, owing to inertia of the insect, there would always be an appreciable time-lag between the change of velocity of the wind and that of the insect. From these pressures, however, the insect would only be able to determine the general direction of the wind if (*a*) changes in velocity of the wind (*i.e.* gusts) were more frequent in the direction of the wind than across it; and if (*b*) the gusts were asymmetrical, either rising more suddenly and dying away more gradually, or vice versa.

At the time of writing, these two ideas were contrary to the generally accepted theory of wind structure which, according to Taylor's Law, required that " excursions of the wind from uniform stream motion are similar in all directions." In other words, if one subtracted the mean velocity from a stream of air the residual motion of the particles would be backwards and forwards, up and down, and right and left, in equal proportion. There was, however, even then, a little meteorological evidence to throw doubt on the universal application of this law.

Since that time further experimental work has been carried out by the Meteorological Office, and in 1932 Giblett and Durst published a report on the wind structure as observed over flat land at Cardington in England, which shows that under certain conditions of air temperature both the conditions (*a*) and (*b*) may occur.

They came to the conclusion that, superimposed on the main stream-line motion of the wind, there are two kinds of changes :—

(1) Gusts and lulls which occur more frequently in the direction of the wind stream and which are asymmetrical, the wind rising rapidly to a maximum and falling more slowly to a lull. These are believed to be due to convectional eddies.

(2) Many smaller irregular oscillations, due apparently to frictional eddies, which are as likely to be in one direction as another, and so obey " Taylor's law."

The first type of variation occurs when the temperature gradient is adiabatic or super-adiabatic. That is to say, when the air temperature gets colder as we rise from the ground as rapidly as, or more rapidly than, can be accounted for by normal expansion (about 5·5° F. per 1000 feet).

When the temperature gradient is sub-adiabatic, and particularly when the gradient is reversed (*i.e.*, warmer air above), convectional currents cannot take place and therefore only the small irregular oscillations are found.

Adiabatic and super-adiabatic conditions most frequently occur during the daytime when the ground is heated by the sun's rays. In rough country with many obstructions, and in hilly country, the frictional eddies may greatly overshadow any convectional eddies.

The alternating development of gust and lull due to convection are of much longer duration than the small frictional eddies. The average convectional cell, the passing of which starts with the gust and ends with the lull, is, according to Durst, of the order of 3000–8000 feet, say a half to one and a half miles, in length. The passing of this may occupy several minutes. Fig. 44 shows part of one of the records from Giblet and Durst for such a gust and it will be seen that the gust occupied about twelve seconds with air accelerations up to about two feet per second^2 while the fall to the lull occupied several minutes and the retardations were of the order of 0·12 per second^2 or less than one-tenth of the force of the gust.

Given such conditions, an insect would be subjected to a pressure from the direction from which the wind is blowing during the sudden advent of a gust, and a much weaker pressure on the opposite side as the gust dies away.

It is important to note that the above discussion has only shown that it might be possible for an insect or bird to determine, from the pressure which it feels, the direction of the wind in which it is flying; but not that it does so.

Acworth (1929) has discussed at some length the effect of wind on flying birds, but his results are of little practical importance as he deals only with an absolutely uniform wind movement, and so comes to the conclusion that the flying bird or insect is not merely unable to tell (except by observing the drift) in which direction the wind is blowing, but even if there is a wind at all.

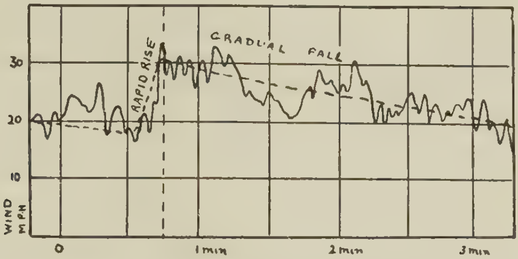

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Fig. 44.—Wind changes during the advent and passing away of a gust due to convectional eddy. After Giblett and Durst 1932.

According to Acworth, if a bird wishes to fly from a point A to a point B with a cross wind (fig. 45), it is unable to appreciate the presence of the cross wind except by the fact that it is moved sideways relative to the relatively distant goal towards which it is flying and towards which it always heads in a straight line. As a result it takes a curved course A C D B and always arrives at B facing the wind. If, however, it could appreciate the wind direction it could allow for it at any moment by flying slightly skew to the desired direction, in which case the bird (or insect) would fly from A to B in a straight line.

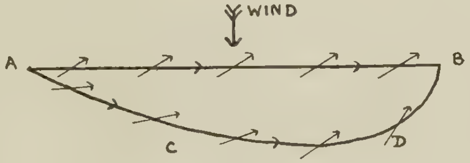

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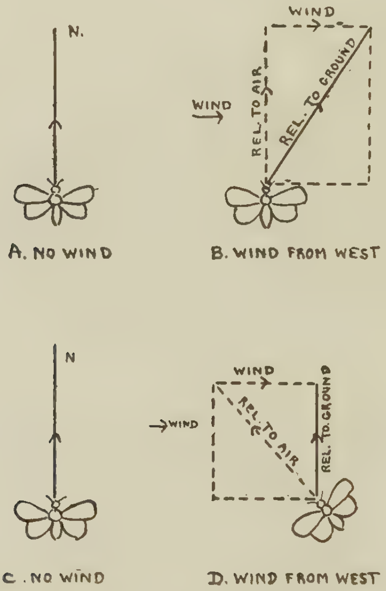
Fig. 45.—Direction of flight of an insect across the wind from point A to point B, to illustrate Acworth's theory.

On Acworth's theory, if a bird were flying to the north in still air and a side wind arose, the bird would be unconscious of this and would continue for some period at least to face the north and to fly through the air in the same direction and speed as before. Its speed and direction relative to the ground would therefore be the resultant of its old speed and that of the wind as shown in fig. 46, A and B, where the insect is presumed to be facing north with a wind from the west, of velocity equal to two-thirds of the speed of the insect. From an observer on the ground the insect would appear to continue to face to the north but to fly diagonally in a new direction (east of north) and also slightly faster (but this latter might be difficult to observe).

If, on the contrary, the insect were conscious of the wind direction and wished to continue to fly to the north it could do so by facing slightly to the west into the wind (fig. 46, C and D). In this case, from the point of view of an observer on the ground, the insect would on the advent of a side wind alter its body line slightly but continue to fly in exactly the same direction as before although at a slightly lower speed (though again this might be difficult to observe). In each case the insect during a wind will be moving (relative to the ground) at an angle to the line of its body, but in the first case the axis of the body will remain constant although the flight direction will alter with each change of the wind; while in the second its ground direction will remain unaltered but the axis line of the body will alter with each change of the wind.



A. NO WIND B. WIND FROM WEST

C. NO WIND D. WIND FROM WEST

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Fig. 46.—Diagram of two possible reactions of a flying insect to a side wind.

I have myself observed exactly the last condition in locusts in East Africa in 1928. In my report on the observations (Williams 1933c) I said, " At times it was obvious on close observation that the locusts were turning their bodies at an angle to the line of flight when the wind blew strongly. Thus, on 29th November at Voi [Kenya] I noted that when there was no wind the locusts were flying to the N.E. with their heads facing in this direction; when, however, the rather gusty wind blew from the S.E. the locusts' heads turned approximately to the east, although their motion relative to the ground remained the same."

In the case of these locusts it must be recognised that they were flying from 4 to 8 feet above the ground and so the possibility of visual observation of the sideways drift is not ruled out. It is difficult, however, to suggest what features of the rough ground beneath them could be used as " sighting points " to keep a constant line of flight.

Mr. P. R. Gleason also has observed butterflies flying at an angle to the wind as if to allow for its influence, in a manner quite similar to my own observation on locusts, during a thin movement towards the east of an unidentified Hesperiid butterfly in New Mexico, U.S.A., in March 1940. The wind was strong and variable, sometimes from the east and at other times from the south-east or south.

He writes: "I wish to mention another peculiarity of the flight which was different from anything I have seen before. When the wind was at a maximum from the south and the insects were travelling straight across it, they faced towards the S.E. as if to avoid being blown to the north of the point they meant to reach. The forward motion, quartering against the wind, drove them straight east, *i.e.* as if they were really headed E. instead of S.E. and no wind was blowing."

The possible effect of wind direction on the density of flights and their frequency of observation.

If a flight of butterflies 2 miles long were moving at a speed of 10 miles per hour in still air it would take 12 minutes to pass any fixed observation post. If this flight passes, as at A in fig. 47, into an area of contrary wind at 5 m.p.h. (so that the insects only move forward with a ground speed of 5 m.p.h.) the front butterflies will have passed only one mile into the new area before the last butterflies have left the old; in other words, the flight will be compressed so as to be only one mile long. But since it is only moving at half the speed it will take twelve minutes to pass an observation point.

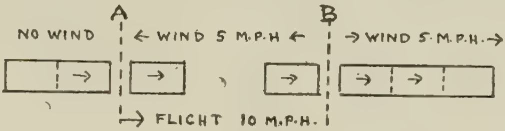

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Fig. 47.—Effect of head and tail wind on the speed of a flight and the time taken to pass an observation point.

If, as at B, it now passes into an area of following wind of 5 m.p.h. it will move forward at a ground speed of 15 m.p.h. and the first butterflies will have flown 3 miles before the rearguard has left the old area, *i.e.* the flight will now be three miles long. It will, however, still take exactly twelve minutes to pass an observation point.

In other words, unless there is deliberate spacing by the insect, the length of the flight from front to rear is directly proportional to the ground speed of the flight, in so far as this is affected by wind; but the length of time taken to pass is the same for all directions and force of the wind, and so the same number of insects will pass any observation point in the same time.

Therefore observations taken on the number of flights (or of insects) that pass a given observation line across the flight in a given period are independent on the force or direction of the wind.

If, however, an attempt is made to estimate the number of insects in a flight by counting those at any moment in a given area, or in a given line in the direction of the flight, the result will be affected by the changes in speed of the wind and will show a greater apparent density when the insects are flying slowly against the wind than when flying quickly with it.

A similar problem, and perhaps more easy to understand, arises if a number of cyclists start at regular intervals of say 15 seconds to cycle up a hill and down the other side. After a short period their distribution will be shown as in fig. 48.

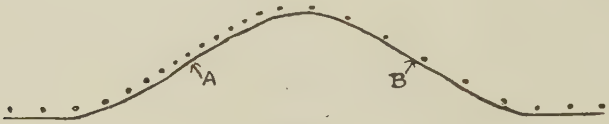

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Fig. 48.—Diagram to illustrate analogy of cyclists moving up and down hill with effect of wind on an insect migration.

The number of cyclists on any given length of road will be greater on the uphill at A and fewer on the downhill at B; but the number passing A per fixed time will be exactly the same as at B, *i.e.* four per minute.

Thus if one wishes to compare the frequency or density of different flights

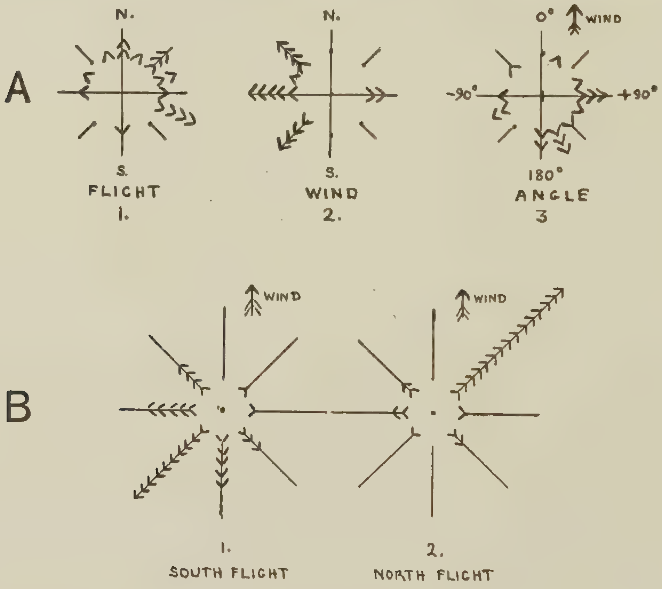

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Fig. 49.—Diagrams showing false apparent effect of wind on direction of migration :— A. Locusts in East Africa; B. *A. monuste* in Florida.

of insects it is important to measure the number crossing a fixed line, at right angles to the flight, per specified time; and not the number present on a specified area at any one moment.

It follows that in any area where there is no prevailing wind, observations of flights will be equally frequent with the wind, against it and across it in either direction, unless the insects composing the flight exert a choice. If, therefore, the records are not so distributed, the discrepancy can be explained either by (A) that there is a tendency for the insects to fly with some definite relation to the wind direction, or (B) that the records suffer from some personal error, such as a tendency for observers to be more likely to note the wind if it is against or with the flight than if it is across, as has already been discussed in a previous paper (Williams 1930b).

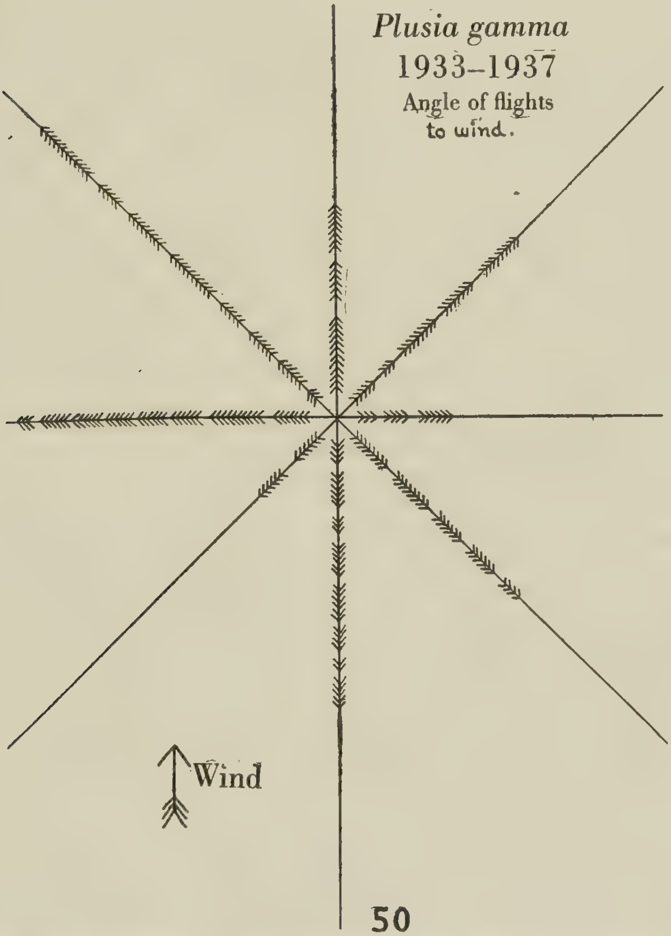

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FIG. 50.—Angle between direction of flight and direction of wind on a number of flights of *Plusia gamma.*

It must be noted that if in any district there is a prevailing wind, and also a more or less regular direction of migration, an apparent relation between wind direction and flight is bound to appear although it will be no evidence of cause and effect.

One example of this has been given in connection with locust flights in East Africa in Williams (1933c) where, out of 16 flights, the wind was towards the N.W. or S.W. in fourteen, and the flights were nearly all towards the N.E., E. and

S.E. As a result (fig. 49, A) there is a preponderance of flights more or less against the wind, but as neither all possible flight directions nor all possible wind directions occurred one cannot draw any conclusion.

An even more interesting example comes from the observations of Mr. and Mrs. Hodges on the migration of *Ascia monuste* in Florida (see p. 143). At the point of observation in Melbourne, Fla., the wind was more frequently from the east and south-east than any other direction. From the 18th March to the 16th May 1938, *A. monuste* was migrating steadily to the south and the relation of these flights to the wind is shown in fig. 49, B 1, from which it might be inferred that there was a definite tendency for the insect to fly into the wind and at a slight angle to it. However, on the 18th May the insect reversed the direction of its flight and flew from that date until the end of June towards the north, and the relation of its flight direction to that of the wind is shown in fig. 49, B 2, exactly the opposite from the previous conditions. In fact, there is no possible inference from these data except that the direction of the flight of the butterfly is determined quite independently of the direction of the wind.

I have already brought forward evidence (Williams 1930b : 368) that there is little or no relation between the general direction of flights and the direction of the wind. Since then other studies have always given the same result.

In 1938 Mrs. Grant showed that in a number of flights of *Plusia gamma* in Britain from 1933 and 1937 the direction of flight was at all angles to the wind, without any preponderance either with, against or across. Her figure is reproduced in fig. 50.

Again in this report on p. 194 there is an account of a flight of *Pieris brassicae* in Harpenden, England, that lasted for three weeks. The wind on successive days ranged almost all round the compass without any alteration in the direction of the flight.

There are also, of course, many records of quite definite flights during periods of dead calm when any orientation by the wind would be impossible.

One must therefore conclude :—(1) that the structure of the wind might allow the insect to determine the wind direction from pressure alone; (2) that there is evidence from the orientation of individuals flying in a cross wind that they do appreciate and allow for wind direction, though whether this is done by vision or by pressure perception is not yet certain; (3) in spite of the above there is still no evidence that the wind direction determines the direction of any migratory flight. Very occasionally the direction may be slightly diverted by a strong side wind, but the main flight direction is quite independent of wind changes.

The possible influence of light and sight on orientation.

In my previous summary I discussed very briefly the possibility of orientation during migration being based on the direction of the light, such as the sun's rays, and came to the conclusion that this was unlikely. Firstly because migration may occur in cloudy weather with a diffuse light; secondly because it can take place at midday in the tropics when the sun is overhead, and so could not give any definite indication of horizontal direction; and thirdly because many migrations take place at night and without even the moon.

Since this was written much more has become known about the general orientation of insects by the direction of light rays, and a good summary has been recently given by Fraenkel and Gunn (1940). They call the reaction the "light-compass-reaction" and give a number of examples. All the above objections still hold, however, against it being considered as the basic determination of the direction of migration.

When one has seen a migration continue steadily in one almost compass-true direction for several weeks on end, at all times of the day and in all weathers except perhaps heavy rain, it is difficult to believe that the direction of the sun's rays can have any importance. The insect would have to allow hour by hour for the changing direction of the rays.

One point of interest here is the effect of fog which would give an almost completely diffuse illumination. The evidence is contradictory (Williams 1930b : 388). Evershed states that in south India the butterflies turned back on reaching a fog bank but returned again and again to the edge of the wall of fog. Moreau in East Africa, on the contrary, records that a migration of *G. aurota* " continued on an afternoon of thick mist when you could not see ten yards in front of you." Undoubtedly, even the presence of thick fog does not necessarily interfere with the sense of direction.

Quite recently Kennedy has carried out experiments on flying insects in relation to the apparent movement of the ground. He finds (Kennedy 1940) that mosquitoes when flying quite close to the ground tend to orientate themselves (particularly in relation to wind) so that (1) the ground never moves from back to front relative to the insect, and (2) the image moves across the retina as slowly as possible—or at least they avoid any condition that proproduces a movement of the image above a critical velocity.

As a result of these conditions a mosquito never flies against a head wind unless it can fly faster than the wind and so make progress up wind; and it avoids flying with a strong tail wind as this increases to above the limit the velocity of its speed relative to the ground and hence the rate of movement of the image on the retina. The insect when near the ground therefore tends to fly against light winds and to alight if they become too strong for it to make headway relative to the ground.

All these experiments have been done with the mosquitoes within a few centimetres of the ground, and it is difficult to say how they would apply to an insect several feet or, still more, a hundred feet or so in the air when the movement of the image of the ground on the retina would be very much slower.

If insects are not guided by wind or by the magnetic field (see below), the most obvious thing left is vision, and this would be likely to be carried out by some form of " sighting " or by the movement of the retinal image. At the present moment, however, one is still far from being in a position to see a solution. Experiments must be carried out in the field to test such possibilities on migrating insects. Such tests might well be carried out at the Research Station at Amani in Tanganyika where flights occur quite frequently and at regular seasons. It should be noted that if an insect is flying in a wind current, the movement of the insect relative to the ground (and hence the movement of the retinal image of the ground in the insect's eye) will not be parallel to the axis of the insect's body on either of the theories of wind orientation discussed on p. 230 unless the insect is flying directly with or directly against the wind.

An observation of my own which might be referred to here in connection with Kennedy's work is that in East Africa in 1928 I saw locusts (recently emerged adults) flying fast with a fairly strong breeze at a height of 10–15 feet above the ground, but lower down at 1–6 feet all were flying in the opposite direction against the wind. All the time hundreds were rising from the lower layer or dropping to it, and all immediately changed their direction as they changed their level (Williams 1933c). This would undoubtedly result in the retinal image moving more slowly, as when they were near the ground their ground speed was at its minimum, and when they were farthest away it was at its maximum.

It is perhaps also worth recording again in this connection that about the same time I saw large numbers of locusts making a steady flight near the ground and all the locusts at rest on the ground were orientated in the same direction as those flying above. It is interesting to note that these locusts on the ground would see objects above them moving from rear to front. This is the condition that Kennedy says is avoided by mosquitoes, for objects below them. Is the difference in the position of the moving objects or in the behaviour of the two insects ?

Experiment on the influence of the magnetic field.

By G. F. Cockbill.

Recorders of the phenomenon of prolonged unidirectional flights of butterflies have at times outlined the possible stimuli that could produce such reactions in the insect. They reasoned along the lines that a steady unidirectional flight would require a constant and prolonged stimulus, such as might be provided by the earth's magnetic field. The assumption has several times been made that the insect can appreciate and respond to this stimulus.

Such writers have either made the suggestion as an interesting speculation or have selected scant evidence to support their views. Thus Ghesquière (1932b) mentions " le sens physiologique de l'orientation magnetique " in surveying the factors concerned in insect migration; Mary (1921) suggests that the sense of magnetic orientation would be a manifestation of unilateral electrical stimulation, while Lakhovsky (1931) even invokes the cosmic rays.

On the other hand, depending on direct observation, Lenz (1931) goes so far as to suggest that the predominantly north-north-westerly flights of butterflies that he observed in northern Germany were to be explained on the grounds that as the magnetic North Pole was some distance to the west of the true North Pole, the insects were accommodating themselves to the earth's magnetic field.

The only experiments carried out on migrating animals to investigate the effect of the earth's magnetic field, as far as the writer is aware, have been those of Wodzicki, Puchalski and Liche (1939). These workers were considering the factors which determine the migration of storks. They caught twelve storks near Lwow, Poland, and sent four to Lisbon, four to Berlin and four to Harviala in Finland. In each group, three storks each had a bar magnet attached to its head, several times stronger than the earth's field " calculated according to Gauss' formula." The fourth stork of each group was used as a control. It was presumed that the presence of the bar magnet, " according to Stresemann's hypothesis, would eliminate the influence of the earth's field " on the birds.

The experiment did not give satisfactory results owing to the small numbers of birds used and also to the very unfavourable meteorological conditions in the latter part of June 1938, when the experiment took place.

No storks returned from Lisbon; three returned from Berlin, including two with the magnets attached to their heads, although their flight was slower than normal; while of the four from Finland, two died, and the remaining two stayed near the place where they were liberated.

This method of investigation would not be practical in insects. On the other hand, because of their small size, insects can be subjected to a controlled environment without much difficulty.

Although it was not thought probable that positive evidence would result, it was considered necessary to carry out some experiments.

The following experiment was designed to compare the movements of nymphal locusts when subjected to a powerful magnetic field with those under normal conditions, and to decide whether the insects under experiment possessed any mechanism for appreciating and orientating themselves in relation to the poles of a strong magnetic field.

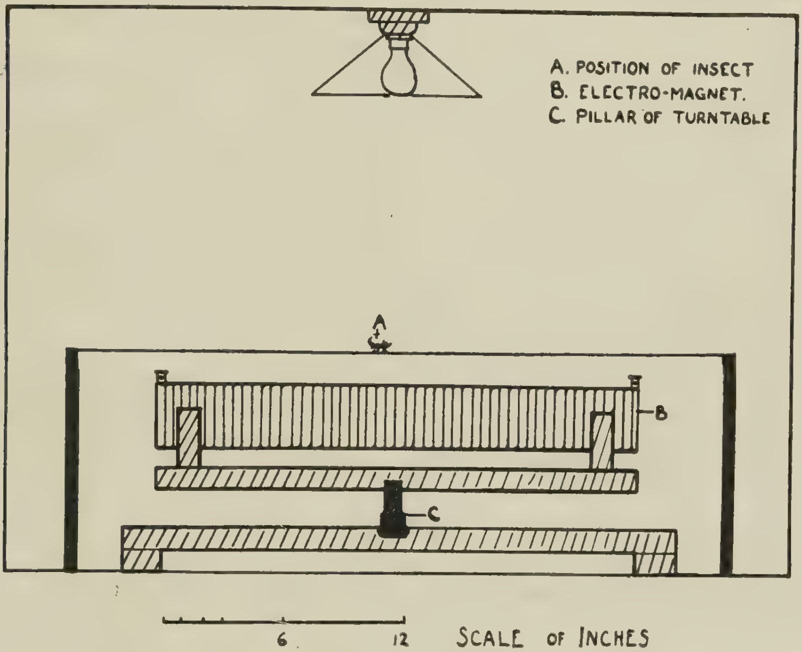

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FIG. 51.—Apparatus for testing the effect of a strong magnetic field on insect orientation. Lateral view.

Apparatus and method.

The apparatus, fig. 51, consisted essentially of an electromagnet made from a transformer coil, supplied with 100 volts D.C., and placed centrally beneath a circular paper platform on which the insects were liberated.

The electromagnet was supported on a turntable which allowed it to be rotated through 180°. A reversing switch was included in the circuit, so that by rotating the magnet through 180° and using the switch, the poles of the magnet could be made to take up any position in the circle.

The entire apparatus was enclosed within an almost lightproof chamber, made of wood laths and brown paper. A flap was left in one side to allow the insects to be deposited on and taken from the platform. From the roof of the chamber hung a 60-watt electric lamp which evenly illuminated the paper platform beneath.

The room in which the experiment was conducted had a northern aspect, and consequently was not subjected to very great daily range of temperature and humidity. Moreover, since each trial lasted only a few minutes, the fluctuations of temperature and humidity during that time were too small to be regarded as interfering with the experiment.

The platform on which the insects were liberated was divided into quadrants. The quadrant lying between N.E. and N.W. was designated North; that lying between N.W. and S.W. was designated West; that lying between S.W. and S.E. was designated South; that between S.E. and N.E. was designated East.

Although the chamber was not completely lightproof, the intensity of the internal electric light was greater than that of the diffused light of the room, and as a result, the electric light was the only effective illumination within the chamber. There was no horizontal illumination gradient.

The insects found to be most suitable for the experiment were those which were fairly active.

To test the reaction of the insects to the apparatus without any current flowing, a locust nymph (*Schistocerca gregaria*), measuring about $\frac{3}{4}''$ long, was liberated in the centre of the platform facing N. It was free to wander over the platform until it reached the edge, when it was collected, and its final position was noted. It was then replaced in the centre facing another direction. The insect was liberated 20 times facing each of the directions N., S., E. and W. In half the trials, the insect was introduced from the W. side, and in half from the E. side, lest the insect be influenced by the mode of entry.

Results.

Table 29 shows the results of the experiment. When the insect was started facing North, it finished up facing North in 16 cases, facing East in 3 cases, and facing West in 1 case.

TABLE 27.

Control experiment to test the response of a Locust nymph to the apparatus for testing reactions to a magnetic field, when no current was flowing.

		Final direction:				Total
		N.	S.	E.	W.	
Initial direction:	N.	16	—	3	1	20
	S.	—	17	—	3	20
	E.	2	3	13	2	20
	W.	—	10	—	10	20
Total .		18	30	16	16	80
	χ^2	0·2	5·0	0·8	0·8	6·8

When it was started facing South, it finished up facing South in 17 cases and West in 3 cases.

When it was started facing East, it finished up facing North in 2 cases, South in 3, East in 13 and West in 2 cases.

Finally, when it was started facing West, it finished up facing South in 10 cases and West in 10.

The final directions were :—North 18, South 30, East 16, West 16 : total 80.

Despite the somewhat large value for χ^2 in the column " Final Direction South," the total χ^2 of 6·8 is not significant even at the 0·05 level.

It appears then that when the initial directions were evenly distributed the final directions were also evenly distributed, and that the insect tended to continue moving in the direction in which it was started.

In the second experiment, four similar locust nymphs were liberated simultaneously from a glass tube in the centre of the platform. They were free to move to the edge of the platform, where their final position was noted. There were 40 trials with the current off, and 80 trials with the current on, *i.e.* 20 trials with the N. Pole of the magnet pointing in the direction of each of the four cardinal points of the compass. This number of trials allowed for an even distribution of the initial direction of the insects. The results and summary are shown in Table 28.

Table 28.

Direction of movement of Locust nymphs in a magnetic field.

Current off								Current on															
								N. Pole to N.				N. Pole to S.				N. Pole to E.				N. Pole to W.			
N.	S.	E.	W.	N.	S.	E.	W.	N.	S.	E.	W.	N.	S.	E.	W.	N.	S.	E.	W.	N.	S.	E.	W.
1	1	0	2	0	0	1	3	1	2	1	0	1	1	0	2	1	0	2	1	1	0	1	2
0	2	0	2	1	1	2	0	1	1	0	2	0	3	1	0	1	1	0	2	1	2	1	0
1	0	1	2	0	1	0	3	2	1	1	0	1	1	1	1	0	1	0	3	1	1	0	2
2	0	0	2	1	0	1	2	1	1	1	1	2	1	0	1	0	2	1	1	1	2	1	0
1	1	0	2	1	1	1	1	2	1	1	0	0	1	2	1	0	2	0	2	1	0	2	1
1	1	0	2	0	2	1	1	0	1	2	1	1	2	0	1	1	1	0	2	0	2	1	1
0	0	2	2	1	0	2	1	2	1	0	1	1	1	2	0	0	1	1	2	1	2	0	1
2	2	0	0	1	1	0	2	1	0	0	3	0	3	1	0	1	1	0	2	2	0	1	1
2	1	0	1	2	0	1	1	1	3	0	0	1	2	0	1	1	1	2	0	1	2	0	1
0	1	1	2	0	1	3	0	3	0	0	1	0	3	0	1	1	1	1	1	0	1	1	2
2	0	0	2	1	1	2	0	0	1	2	1	1	1	2	0	1	2	1	0	1	1	1	1
1	2	1	0	0	2	1	1	0	1	2	1	1	2	1	0	0	1	0	3	0	1	3	0
3	0	1	0	0	2	1	1	0	1	3	0	1	1	1	1	1	1	0	2	1	1	2	0
1	1	1	1	1	1	2	0	1	1	2	0	2	1	1	0	1	0	0	3	0	3	0	1
1	3	0	0	1	2	1	0	0	3	0	1	2	0	1	1	1	3	0	0	1	3	0	0
1	1	1	1	1	0	3	0	1	0	2	1	2	1	0	1	0	2	1	1	1	2	0	1
3	0	1	0	0	3	1	0	1	0	2	1	2	1	1	0	1	2	1	0	0	2	1	1
2	0	1	1	1	1	1	1	1	2	1	0	0	2	1	1	2	1	0	1	0	1	3	0
2	0	1	1	2	2	0	0	1	1	1	1	1	2	0	1	1	2	1	0	0	2	2	0
2	2	0	0	0	2	1	1	1	0	3	0	1	1	1	1	0	0	2	2	0	0	2	2
28	18	11	23	14	23	25	18	20	21	24	15	20	30	16	14	14	25	13	28	13	28	22	17
			N.	S.	E.	W.						N.		S.			E.		W.				
Average .			21	21	18	20						20		2·75			19		18·25				
χ^2 . .			0·1	0·03	0·4	0·03						0		1·5			0·2		0·61				

Discussion.

From the experiment no evidence was forthcoming to suggest that these insects did appreciate or orientate themselves in relation to a magnetic field. If the insects could appreciate and respond to the effect of the magnetic N. Pole, they would have distributed themselves relatively the same in all positions of the N. Pole of the electromagnet with an uneven distribution among the four points N., S., E. and W. However, as far as the experiment shows, the insects moved without regard for the magnet's position, as can be seen from the insignificant values of χ^2 in Table 3.

Other insects, namely *Calandra granaria* and *Araecerus fasciculatus* adults, and *Tenebrio molitor* adults and larvae, were used, but in no case was there any suggestion that the insect could appreciate a change in the magnetic field.

These conclusions would appear to be consistent with the behaviour of migrant insects in nature. If migrating insects orientated themselves to the earth's field, they would undergo a cyclic shifting in their directions of flight to compensate for the cyclic motion of the earth's magnetic poles. Although it has never been especially looked for, there is no reason to suppose that there has been any such movement in migratory birds over the many years that they have been observed. There have been occasional references to the occurrence of insect migrations in the tropics simultaneous with magnetic storms, but they are so few that they are best regarded as being coincidences.

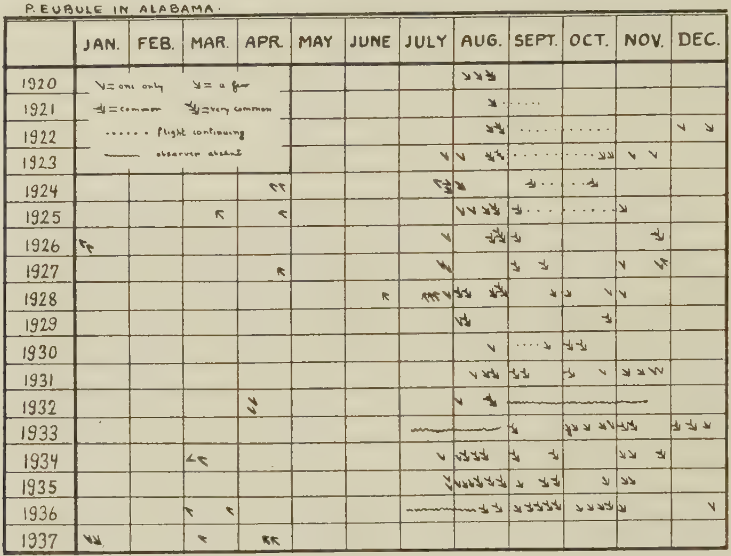

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Fig. 52.—Evidence of return flight in *Phoebis eubule* in Alabama.

IX. The problem of the return flight.

By C. B. Williams.

The Evidence.

The problem of the existence of a return flight in some or all of the migrating butterflies still remains one of fundamental importance and it is proposed to review first the evidence that has accumulated on this point so that the discussion which follows need not be encumbered by enumeration of facts or data.

Phoebis (*Catopsilia*) *eubule.*

The most striking evidence of a return flight of this species has been observed, at Montgomery, Alabama, over a period of about seventeen years by Mr. P. H. Smyth (Williams 1938b). He recorded the direction of flight of the butterflies observed crossing a park at frequent intervals from the autumn of 1920 to the spring of 1937. During that period very large numbers passed towards the south-east every year from the end of July to the beginning of December, and much smaller numbers were occasionally seen in the spring during March and April passing in the opposite direction to the N.W.

Fig. 52 gives a summary of his observations and shows how regularly the flights occurred.

Catopsilia pyranthe (and possibly other *Catopsilia* spp.).

At Kodaikanal in South India, Evershed has observed (1927, Williams, *Trans. ent. Soc. Lond.* **75** : 9) large flights of *Catopsilia pyranthe* and other species to the south in October and November in several years; and flights in the opposite direction, towards the north, in February and March. *C. pyranthe* was definitely identified in these return flights, but other species were probably also present.

Colias croceus.

In my previous summary of this species (Williams 1930 : 133) only seven directional flights were recorded of which two were towards the south in the autumn. One of these was in Dorset, England, in September 1928 and the other near Cannes in the South of France in September and October 1921.

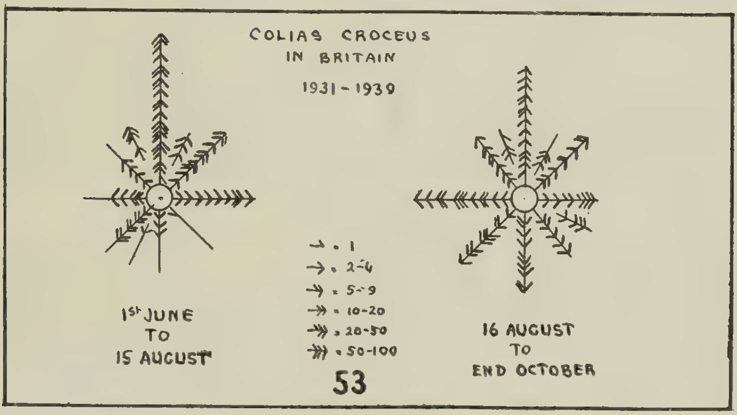

Fig. 53.—Evidence of return flight in *Colias croceus* in Britain.

Since then three other late summer or autumn flights have been recorded as follows :—

1900, Oct. 10. Hautes Pyrénées, France. To S.
Serried column seen by M. Rondu (Williams 1935d).
1928, Aug. 7–14. Nr. Chamonix, Switzerland. To S.W.
Incredibly abundant and moving steadily. Warren (1928).
1934, Sept. 27. Royan, Charent Inf., France. To S.
Suddenly abundant and moving to S. Bon (Williams 1935d).

On the other hand, an examination of a large number of records of the direction of flights of *C. croceus* in England, usually, however, fewer than a dozen individuals at a time, does not show any predominantly southerly flight (fig. 53), such as that shown in *V. atalanta* by the same method.

Since, however, in south England one is very near the northern limit of the normal distribution of *C. croceus* it might be expected that the southerly autumn flight would not be so obvious here as it would be farther south in France when larger numbers of individuals would be available to join in them.

Kricogonia lycide.

S. F. Aaron (1929) states that in the Rio Grande district of Texas countless numbers of this species fly southwards towards and into Mexico at the end of the dry season about September : then, in April and May, another flight takes place in the opposite direction towards the north in greatly reduced numbers.

Several other records exist of the spring flight to the north, but the large autumn flights to the south have not so far been recorded by other observers.

Ascia monuste.

Although this species undoubtedly flies both to the north and to the south in Florida, it is not certain that it comes under the category of a species with a true return flight at a later period.

The evidence available up to the end of 1937 has been summarised (Williams 1938) and seemed at the time to support Fernald's Theory that there was one centre of migration in North Central Florida from which butterflies flew away both to the north and to the south.

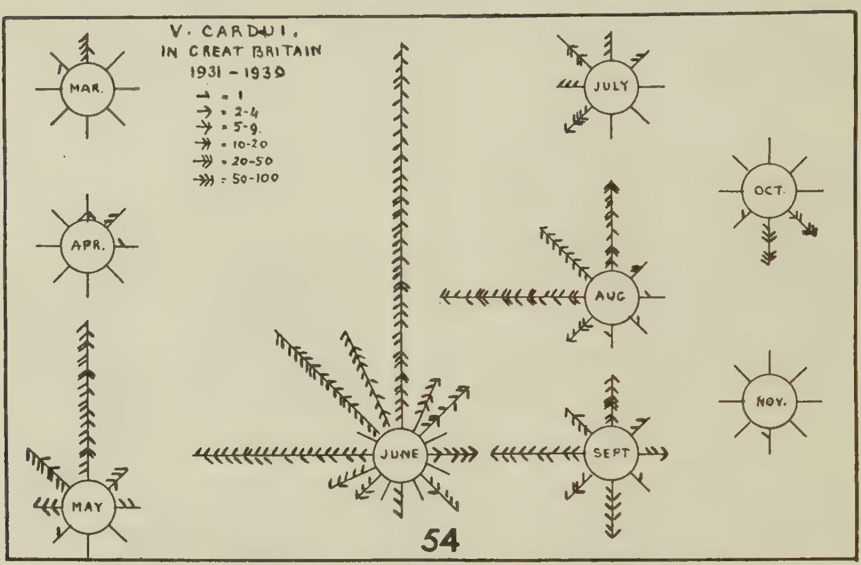

FIG. 54.—Evidence of return flight in *Vanessa cardui* in Britain.

Since then, however, considerably more evidence has come in from the regular observations of Mr. and Mrs. Hodges (see p. 143) and they have shown that at Melbourne, Florida, in both 1938 and 1939 there was a quite definite and sudden reversal in direction in the middle of the flight season. In 1938 the insects flew to the south from mid-March to the 16th May and to the north from the 18th May to the end of June. In 1939 they flew again to the south from early March to the 10th June and to the north from the 11th June to the end of July.

Vanessa cardui.

There is as yet no evidence of a southerly movement of this butterfly in the U.S.A. and there is little or no new evidence in favour of a return flight in Europe.

In my previous summary (Williams 1930b) the most important piece of evidence brought forward for the southerly movement was information received from an entomologist and ornithologist Dr. Walter Innes in Egypt. He stated that he had on many occasions been on the north coast of Egypt at the time of the autumn immigration of the quail. These arrive in great numbers in the early morning, flying low over the sea. Dr. Innes states that on several occasions he had seen small numbers of Painted Ladies, sometimes in groups of two or three, come ashore from the north with the quail. There is no reason to doubt the truth of these observations, but so far no one has had the opportunity to repeat them.

In England the direction of flights of individuals and small numbers of butterflies recorded by numerous observers from 1931 to 1939 have been tabulated in fig. 54, but while they show a preponderance of northerly flights in May and June, there is in the autumn, except in October, no definite preponderance of flights to the south. It can be said, however, that there are more records of southerly flights in the autumn than earlier in the year.

The evidence for the return flight of this butterfly is disappointing in view of the regularity of the appearance of the insect in two continents. It appears likely that the return does takes place in Europe and North Africa, but the evidence is not easy to obtain.

Vanessa virginiensis.

On p. 154 of this report evidence of a return flight in this species is brought forward from the observations of Mr. and Mrs. Hodges in Florida. They record a southerly movement in September 1938, and a northward movement during March 1939. The autumn movement to the south had also been previously recorded by Shannon (1917, *Amer. Mus. J.* **17** : 33).

Vanessa atalanta.

Evidence about the movements of the Red Admiral Butterfly in Great Britain has greatly increased in the past ten years and the results of two years' close observations have been summarised by Mrs. K. Grant (1936a).

She has shown first by a study of the numbers present in different parts of England that they begin to disappear in the north before the south, and further that the disappearance in the north (usually about the end of September) is accompanied by a sudden increase in the numbers in the south.

Secondly when the recorded flight directions of individuals or small numbers of butterflies sent in by numerous observers were tabulated for the years 1934 and 1935 Mrs. Grant found that (1) up to the end of July the flights were predominantly to the north and (2) during September and October the flights were predominantly to the south.

Since then the records for 1936–1939 have been studied, and fig. 55 shows the combined results of the observations in the 6 years 1934–39.

The previous conclusion is completely supported and the preponderance of northerly flights in May, June and July and of southerly flights in September and October is quite striking.

On two or three occasions, for example on the 23rd September 1934 at Start Point Lighthouse in Devon, and on the 26th–27th September 1935 at Round Island Lighthouse in the Scilly Islands, Red Admirals were seen to pass out to sea towards the south in numbers.

Still further evidence of autumn movement, although not of the direction of flight, is found in Fletcher's observations that butterflies marked in the autumn at Stroud, Gloucester, were very seldom seen again at the point of marking (see p. 224).

On the continent of Europe evidence of a return flight in the autumn has been brought forward by E. Fisher (1919), who saw a definite flight to the south near Zurich in September 1910, and by Foltin (1937a and b), who records definite southerly flights at Zell-am-Pettenfurst in Upper Austria at the beginning of October in each of the three years 1932, 1934 and 1936.

Dione vanillae.

Strong evidence of a return flight in *Dione vanillae* has been brought forward in this report (p. 149) by Mr. and Mrs. Hodges in Florida. They observed thin but definite movements towards the north in the spring, especially March and April, of 1938 and 1939, and very definite and quite conspicuously large flights towards the south in September and October of the same years.

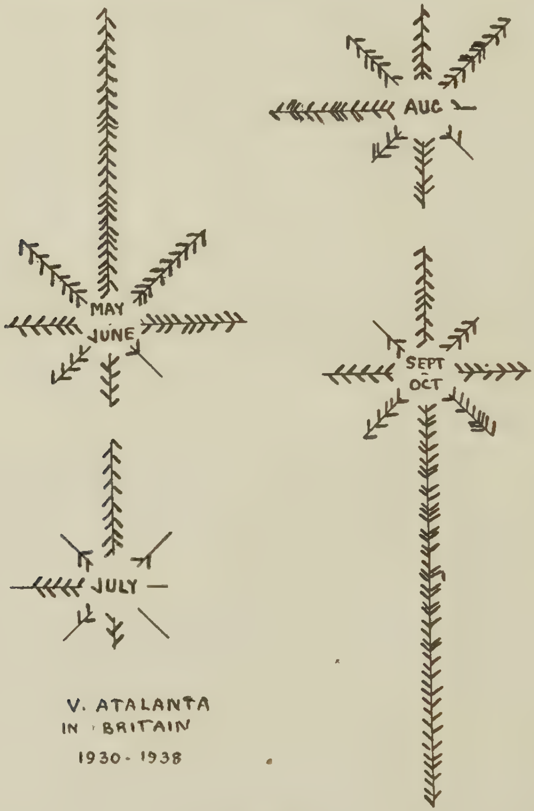

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Fig. 55.—Evidence of return flight in *Vanessa atalanta* in Britain.

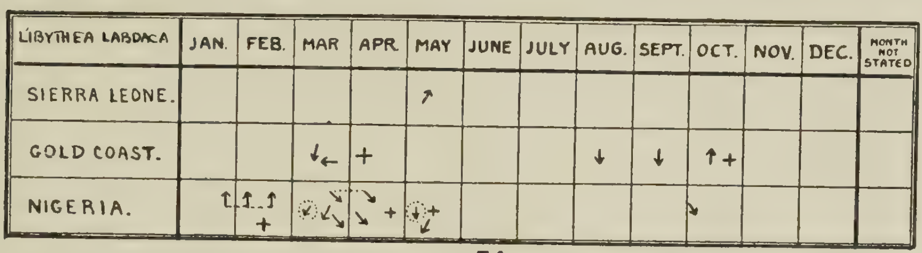
Libythea labdaca.

Farquharson (1918 and 1922) recorded this butterfly in Nigeria as flying southward early in the rains about April; and returning northwards " towards the end of the rains." The month when this return occurred was not given nor were there any exact records of either flight.

In 1930 I had collected about a dozen records of flights for Nigeria, Gold Coast and Sierra Leone. Most of the flights, including all from Nigeria, were in March, April and May and in a southerly direction as stated by Farquharson. There were, however, two flights recorded later in the year (in August and September in the Gold Coast) but they were also to the south.

Since the above summary was made several new records have come in (Williams 1933b and 1939a), three of which are in the second season in October, but only one of these is towards the north. On the other hand, there is a record of a flight to the north in January and February which is difficult to reconcile with Farquharson's statement. Miss Vinall (Poulton 1933d) has recorded migrations of *L. labdaca* at Bongandenga in Belgian Congo in April and in August 1932, but in neither case was the direction of flight reported.

Fig. 56 shows a summary of the present known records. In spite of Farquharson's definite statement, the question of return flight in this species is still somewhat doubtful.



LIBYTHEA LABDACA	JAN.	FEB.	MAR	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	MONTH NOT STATED
SIERRA LEONE.					↗								
GOLD COAST.			↓ ←	+				↓	↓	↑ +			
NIGERIA.	↑	↑ ↑ +	↙ ↘ ↙ ↘	↘ ↘ +	↓ + ↙					↘			

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FIG. 56.—Evidence of a return flight in *Libythea labdaca* in West Africa.

Danaus plexippus.

There is now no doubt whatever as to the existence of a return flight in the movements of this butterfly. No other explanation will fit the numerous records that have already been given (Williams 1930b and 1938b and on p. 165 of the present report).

The evidence in this species is even more definite as it seems certain that the northerly flight in the spring in North America is performed by the same *individuals* which moved south in the autumn, and not merely by other individuals of a later generation. In no other species does the evidence suggest this conclusion.

Danaus berenice.

Mr. and Mrs. Hodges have observed in Florida thin but definite northward flights of this species in spring and early summer, and quite definite southward flights in the autumn, particularly in September and October (see p. 148).

Andronymus neander.

The recorded flights of this butterfly in East Africa are discussed on p. 220. The majority of flights are in March and April towards the south and southeast. The only records at this period of the year not in this general direction consist of a few individuals in flights of other species of butterfly. On the other hand, the only record at another period of the year, in October, is towards the north. The evidence is suggestive but does not yet prove a return flight.

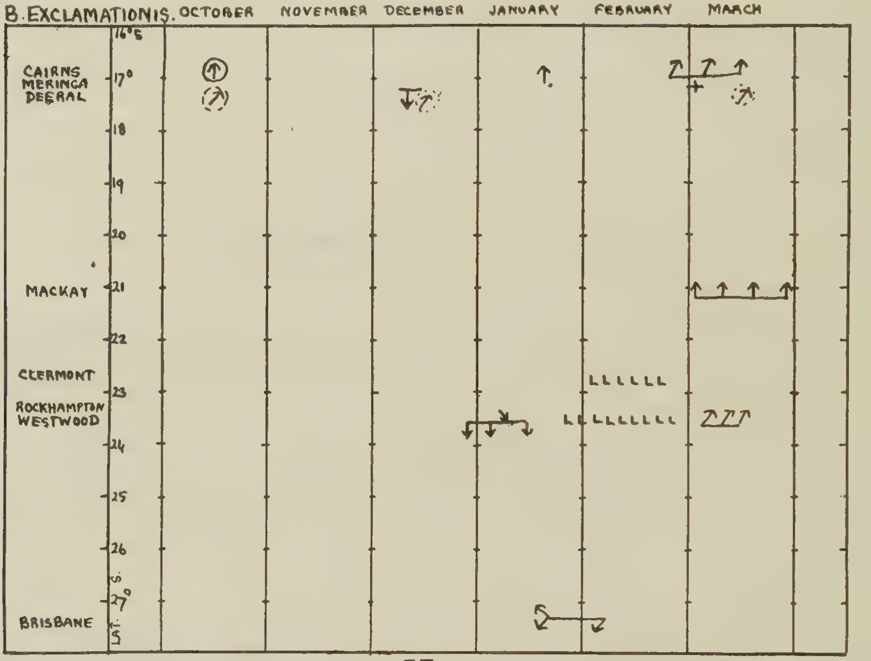
Badamia exclamationis.

Burns (1933) has stated that in the coastal district of Queensland he has observed flights of this butterfly more or less towards the south at Cairns, near Rockhampton, and at Brisbane in December and January; the flight being later in the south than in the north. Then after an interval of about six weeks (during which a generation develops at Rockhampton) flights in the reverse directions, towards the north, have been seen at Rockhampton, Mackay and Cairns. The observations are shown diagrammatically in fig. 57.

Plusia gamma.

The evidence for the return flight of this species in Great Britain has been recently summarised by K. Fisher (Mrs. Grant) (1938) and the summary diagram of her results has been reproduced in fig. 58.

It will be seen that from May to July the majority of the insects are observed moving to the north; in the first half of August there are movements to north, west and south, but not to east; while from the middle of August to the end of October most of the flights are towards the south. Throughout the whole year there is little or no evidence of any easterly movement.



57

FIG. 57.—Evidence of a return flight in *Badamia exclamationis* in Australia.

The southward movements included two very large flights observed at the Start Point Lighthouse in South Devon by Mr. W. A. Godfrey: one on the 12th September 1934 and one on the 4th August 1935; in both cases the insects were flying in thousands out to sea to the south.

Urania fulgens.

Many years ago Friedrich (van Bemmelen 1857) stated that this day-flying moth migrated every year in the state of Vera Cruz, Mexico, beginning in April for two or three weeks towards the north and returning in the opposite direction about six weeks later.

It is now known that this insect migrates regularly in most of the Central American States and the evidence on reversal of flight has recently been summarised (Williams 1937c).

There is evidence of two flight periods: one from about March to May and the other in July and August. In the former the flights are predominantly to the north and in the second to the east and south, but there are exceptions in both seasons.

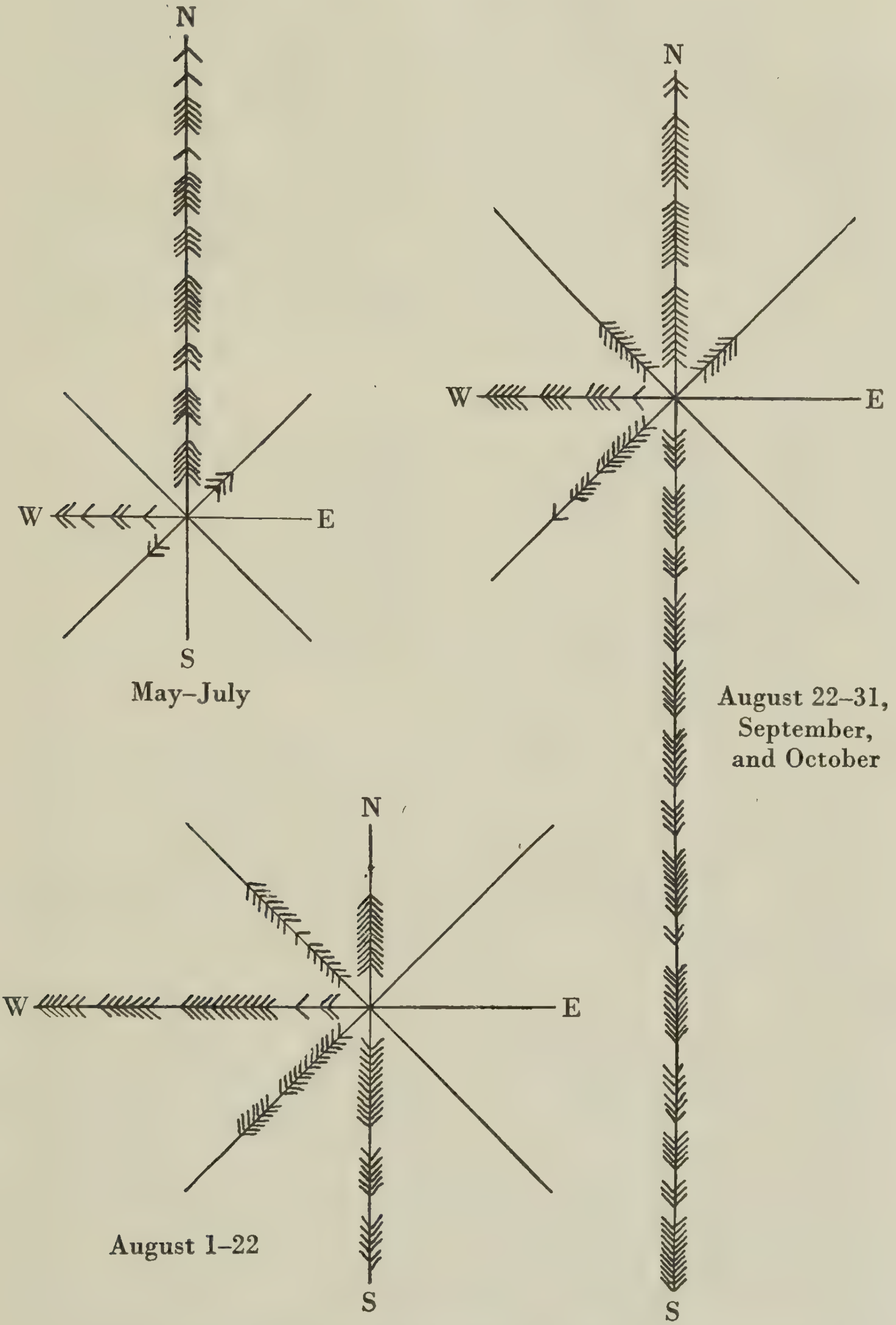


FIG. 58.—Evidence of a return flight in *Plusia gamma* (from *J. anim. Ecol.* 1937).

Since the above summary was made, Mr. A. F. Skutch has reported that in Costa Rica in 1938 he observed flights to the north in April and May, and then about the beginning of June the insects began to fly to the south and continued till the end of August. Even during this period, however, a minority continued to fly to the north. The flight ceased at the beginning of September.

Mr. P. A. Vedoua also reports a flight to the north at the end of March and beginning of April, 1939, at San José, Costa Rica.

Mr. W. Schaus also writes that he had on several occasions observed the north-westerly flight of *U. fulgens* in Mexico on the eastern slopes; and that on one occasion he thought that there had been a flight in the opposite direction, but no date was recorded.

On the whole the new evidence lends support to the theory that this moth has a definite return flight at a later season of the year.

The evidence for a return flight is summarised above for the following fifteen species.

- Pieridae.
  - *Phoebis eubule* (U.S.A.).
  - *Catopsilia pyranthe* (India).
  - *Colias croceus* (W. Europe).
  - *Kricogonia lycide* (U.S.A.)?.
  - *Ascia monuste* (Florida)?.
- Nymphalidae.
  - *Vanessa cardui* (Europe).
  - *Vanessa atalanta* (Europe).
  - *Dione vanillae* (U.S.A.).
- Libytheinae.
  - *Libythea labdaca* (W. Africa)?.
- Danaidae.
  - *Danaus plexippus* (U.S.A.).
  - *Danaus berenice* (U.S.A.).
- Hesperiidae.
  - *Andronymus neander* (E. Africa)?.
  - *Badamia exclamationis* (Australia).
- Noctuidae.
  - *Plusia gamma* (Europe).
- Uraniidae.
  - *Urania fulgens* (C. America).

Of these the evidence is not very definite in five but in the ten remaining insects there is good evidence of the existence of a return flight. This is not a high proportion of the known migrants, but is quite a high proportion of those in which there is sufficient evidence to justify any conclusions.

Reference should also be made to the fact that the flights of moths and butterflies recorded at the British lightships showed a change in direction from predominantly west and north-west up to mid-August to south and south-east after this date (see p. 140 of this report).

Discussion.

In 1931 there appeared posthumously a book *Emigration, Migration and Nomadism* by Dr. Walter Heape, F.R.S. The author had died in 1929 and the book was edited and supplied with a preface by Dr. F. H. A. Marshall. Thus the essential portions of it were written before my own book on the migration of butterflies appeared, but it was published afterwards.

The author, from previous experience as a physiologist, starts with the basic assumption that there are two fundamentally different types of mass movement in the animal kingdom. The one, in which there is a return movement at a later season, he designates "migration"; and the other, in which there is no return, he calls "emigration." He also considers that the two types of movement are due to two fundamentally different physiological causes which he defines as "gametic" and "alimental"; or, in other words, one due to an urge for reproduction, and the other to the need for food.

In the former class he puts the migration of most birds, turtles, most fishes including the eel, some crabs, and among insects the APHIDAE, some locusts and the single butterfly *D. plexippus.*

Among the " emigrants " are the lemming, the spring-buck of S. Africa, the moose, certain rats, a few birds, including Pallas' Sand-Grouse, most locusts, dragonflies, and all " migrant " butterflies and moths with the single exception given above.

He objects very strongly to the use of the word " migration " for any movement in which a return has not been demonstrated, and wished to confine the use of the word " emigration " to movements which are believed to be in one direction only.

His classification appears at first to have the merits of simplification, but on the whole I am not in agreement with his theories, particularly as they concern the Lepidoptera.

Terminology.

If it is correct that there are two essentially different processes of migration with fundamentally different causes and so presumably separate origins, it is most certainly desirable to have different words to express them. I have, however, already pointed out (1920, *Trans. ent. Soc. Lond.* **1920** : 215) that a " migration," in whatever sense the word is used, consists in sequence of three processes according to the locality from which it is viewed; there is an " emigration " from the point of origin; a " transmigration " at any point on route; and an " immigration " at the point where the migrants come to rest. It seems therefore very unsatisfactory to take a word that means an essential part of any migration and to restrict its use to a phenomenon which one believes to be fundamentally distinct. If the word " migration " is used in any restricted sense, then " emigration " should not be used in any other meaning than a portion of this process. I suggest that if " migration " is limited to movement in which a return journey is established, then the word " exodus " might be used for those without a return.

The reality of the difference between " migration " and " exodus " in Lepidoptera.

Twenty years ago a return flight at a different time of the year had not been established in any species of Lepidoptera with the doubtful exception of the Monarch (*D. plexippus*).

In my book in 1930 it was definitely established for this butterfly and suggested to occur also in *V. cardui* in Europe, in certain Catopsilias in India, in *L. labdaca* in West Africa, in *Catopsilia sennae* (*P. eubule*) in U.S.A. and in the moths *Urania fulgens* in Central America and *Agrotis ipsilon* in India.

Up to that time it can be said that practically no regular observations on the migrations of butterflies had ever been made. The evidence available was only a large number of scattered records of any flights that had been conspicuous enough to force themselves on the notice of some observer who, up to that moment, had not been in any way interested in the problem.

Now for about ten years there has been a greatly increased interest in the subject and a few scattered observers actually watching for movements and ready to observe both thick and thin flights. The need for a classification (see p. 260) which includes densities down to one butterfly per 100 yards per minute shows how thin a flight can now come under observation.

As a result, the number of species with suspected returns (pp. 240 to 248) has more than doubled. The southward autumn flight has been demonstrated beyond doubt in such species as the Red Admiral (*V. atalanta*), which twenty years ago was hardly considered as a migrant; and in the Silver-Y moth (*P. gamma*), known as a migrant for fifty years, but never previously considered to return S.

In fact, evidence of a return begins to appear in nearly every species when sufficient records are available, and particularly when efforts have been made to get continuous observations at all times of the year, instead of only during the period of conspicuous flight.

The more that information is available about the species in which a return flight occurs, the more frequently it appears that the flight in one direction is conspicuous and the flight in the other direction difficult to observe. Thus the Monarch migrates southward in autumn gregariously in large bands which attract popular attention, but the butterflies go northward in the spring individually, and it requires a careful watch to demonstrate the movement.

Phoebis eubule, as observed by Smyth in Alabama (fig. 52), has a conspicuous autumn flight in large numbers, and a spring flight in the opposite direction in very much smaller numbers.

The southward flight of *V. atalanta*, already referred to, has been demonstrated almost entirely from the flights of individual butterflies, recorded by a number of observers none of whom was probably conscious of any extensive directional movement taking place. Thus it is likely that many, if not most, " return flights " have been still overlooked.

Even today the available evidence on Lepidoptera is still strongly biased in favour of conspicuous mass flights, and it is dangerous to theorise too much on the meaning of the apparent absence of a return. Absence of evidence is not evidence of absence.

There is still another difficulty in connection with movements without a return flight, which I have already pointed out and which has been discussed by Elton (1930). This difficulty is not a practical one of obtaining unbiased evidence, but a theoretical one of evolutionary development. If in any species there is a permanent home from which an " exodus " of part of the population occurs at intervals (regular or irregular); and if this portion goes away to die elsewhere without leaving any progeny, while the species is kept going only by the progeny of the individuals which stay behind: under such conditions how is the instinct to " migrate " perpetuated?

If for fifty thousand years (or so) *Vanessa cardui* has persisted in parts of North Africa, and every year a large portion of the population develops an urge to fly away to Europe—there to die—why does the urge to move continue to appear in the North African butterflies all of whose ancestors in a direct line for many thousands of generations must have been the individuals who did *not* develop the urge to migrate?

Modern theories of evolution, from Darwin to the statistical geneticists, demand a survival value for any characteristic which is to persist. How then can an instinct be so widespread, if, instead of a survival value, it carries a certainty of extinction and sterility to the individual possessing it?

This difficulty is so serious that in 1930 I wrote of migration without a return flight " the majority of butterflies seem to come under this heading, but whether this expresses a biological truth or is only the result of our lack of knowledge it is impossible to say at this time."

After a further ten years of examination of evidence I still cannot overcome the evolutionary difficulty and I can still point to no butterfly in which the absence of a return flight has been established beyond reasonable doubt. It is of course always difficult to prove a negative case, but in Lepidoptera, at least, the search for evidence has not been carried out sufficiently far to justify a theory requiring two fundamentally different processes of migration, using the word in its widest sense.

I should also suggest that, even in the case of so well known a creature as the lemming, no one has made any serious effort to watch for movements on a very small scale in between the periods of great overflow nor has anyone tabulated the direction of movement of large numbers of single individuals of any of Heape's " emigrant " mammals at all seasons of the year or for a series of years. The difficulties are great, but Mr. Smyth's seventeen-year diagram (p. 240) might be set up as an example worth following.

Heape's classification of the causes of the two apparent types of migration also brings many difficulties in its train. He himself finds that it breaks down almost immediately, and he has to recognise several other causes including " climatic " and " over-population." If fact he finally states that the causes of " *emigration* " can be : (1) alimental; to get food; (2) climatic; to get to a better climate; or (3) the result of over-population.

In " *migration* " the movement towards the breeding area is gametic (the urge for reproduction), while the movement away from the breeding area is either climatic, or alimental, or the result of over-population, in fact the causes are the same as his " emigration." So in his fundamentally distinct " migration " the gametic urge has to alternate with a non-gametic urge to produce the regular backward and forward movement of the population. He cannot have a gametic " migration " without an alternating " emigration."

Nearly all butterflies and moths he would classify under the " alimental " stimulus, yet they do not migrate until the adult stage when all the main feeding of that individual has been done. So far from having received any early indication of approaching food shortage, the migrating butterflies, moths (and locusts) have usually large stores of reserve energy stored up in the form of fat-bodies, which can later be used for locomotion or for egg production.

Most of the evidence that Heape produces is from the birds, fishes and mammals. At one point he discusses the effect on the regularity of migration of the exceptionally long life and slow reproduction of the elephant, but he does not seem to have taken into consideration sufficiently the opposite effect of the short life of insects and other invertebrates. Is it only a coincidence that most of his examples of " migration " are from long-lived vertebrates, and most of his examples of " emigration " from the invertebrates ?, or that the only species among butterflies that he will allow to " migrate " is the Monarch which has an exceptionally long adult life of nearly one year ?

The phenomenon of the return flight cannot occur with quite the same regularity in Lepidoptera with their short lives, high birth and death rate and violent fluctuations in population numbers as in, for example, the birds with relatively long lives, and low death and birth rate, or at the other extreme the elephant with very long life, low birth rate and (until the evolution of *Homo sapiens*) a low death rate.

It is perhaps at this point worth drawing attention again to the curious fact that among the butterflies in which the return flight has been established, in Europe the spring flight to the north appears to be the more conspicuous and undertaken by larger numbers that the return flight in the autumn; while in the case of the American butterflies (except *V. cardui*) the southward flight in the autumn is much more conspicuous than the northward flight in the spring. The American migrants seem to increase their numbers in the north during the summer and reduce them in the south during the winter; while the European migrants appear to reduce their numbers in the north during the summer and increase them during the winter in the south.

If the evidence has been correctly interpreted, it is difficult to find a reason. Two suggestions can, however, be made. In the first place most of the evidence of migrations of butterflies in Europe has been collected in England and Germany in latitudes approximately 48–55° N.; whereas in America most of the records come from areas in latitudes 30–40° N.; at least 15° or a thousand miles nearer the Equator and at a level equivalent to North Africa and the Mediterranean basin on the other side of the Atlantic. It is possible that if more intensive studies could be carried out in the south of Europe the autumn flights would be found to be more conspicuous, as indeed has already been found with *Colias croceus* in the south of France.

The other possibility is that the different configurations of the two continental areas may have an effect. In Europe there is the Mediterranean in latitude 30–45°, apparently frequently crossed by large numbers of migrants, and south of which the sub-tropical area still continues in North Africa, where many of our European immigrants breed during the winter.

In America, on the other hand, there is the much wider Caribbean Sea in latitude 10–30° N., cutting out a very large sub-tropical breeding area. North of this there is only a very narrow belt of sub-tropical land (Florida and parts of Mexico) and south of it there is the essentially different damp tropical climate. Considering the frequent sea traffic and the number of small islands, there are very few records of migrant insects crossing from the north of South America to the Gulf States of the U.S.A.

It is interesting to note in this connection that *Vanessa cardui*, the one butterfly that migrates into the U.S.A. from the south in very large numbers in the spring in the same way as in Europe, comes apparently from western Mexico, the only portion of the southern boundary of the U.S.A. where there is a large land area with a dry sub-tropical climate such as is found in North Africa.

X. CORRELATION BETWEEN OCCURRENCE OF MIGRANTS IN U.S.A. AND EUROPE.

By C. B. WILLIAMS.

In 1937 Mrs. K. Grant made a study of the years of occurrence in numbers of the Striped Hawk-Moth (*Celerio lineata livornica*) in Europe and of the American race of the same species (*C. lineata lineata*) in the United States. Fairly good information was obtained from both continents over a period of sixty years, 1876–1935.

The insect occurred in unusual numbers in Europe in 23 of these years and in America in the same number. When the years were divided into the four possible groups of (1) occurring in both Europe and America, (2) occurring neither in Europe nor America, (3) occurring in Europe but not in America, and (4) vice versa, the frequency distribution was as shown in Table 29, A.

If the sixty years, including 23 occurrences in Europe and 23 in America, were completely randomised in the four categories the number expected in each would be as shown in Table 29, B.

From these it will be seen that the observed numbers are in excess in the categories " occurring both in Europe and America," and " occurring in neither," but are below the expected in the other two. The evidence therefore shows that there is a tendency for large migrations to occur simultaneously in both continents.

For those who are statistically minded, the test of the significance of the departures of the observed results from those calculated from an assumption of no correlation, gives $\chi^2 = 4{\cdot}0$, which is a significant result with a probability just below 1 in 20. In other words, such a result could be got by accident only about once in about twenty-two trials.

This conclusion was of great interest and an opportunity has been taken to get a similar series of data for the Painted Lady Butterfly (*Vanessa cardui*), which also migrates in both continents and is not even racially distinct in each.

Table 29.

Distribution of occurrence of *C. lineata* in Europe and N. America. A. Observed frequency; B. Frequency calculated on no correlation.

	A.—Observed frequency.			B.—Frequency calculated on no correlation.		
	In Europe	Not in Europe	Total	In Europe	Not in Europe	Total
In America . .	13	10	23	9	14	23
Not in America . .	10	27	37	14	23	37
Total . . .	23	37	60	23	37	60

It has not been easy to obtain good information for all the years as the insect is not a serious pest and thus is not so frequently recorded in the literature of Applied Entomology. On the other hand, it is not sufficient of a rarity to be recorded regularly by collectors. However, it is unlikely that many really large outbreaks have passed unrecorded.

After examination of a large number of records the information in Table 30 has been collected to show whether or not the insect has been above the average in numbers in either Continent in each of the 74 years from 1865 to 1938.

From these data Table 31 has been prepared on the same lines as Table 29

Table 30.

Years of above the average abundance of *V. cardui* in Europe and America, 1865–1938.

	Eur.	Am.		Eur.	Am.		Eur.	Am.		Eur.	Am.
			1880			1900	c	c	1920	c	c
			1881			1901		c	1921		
			1882			1902	c	c	1922		
			1883	c		1903	c		1923		
			1884	c	c	1904			1924		c
1865	c	c	1885	c		1905			1925		
1866			1886		c	1906	c		1926	c	c
1867			1887			1907	c	c	1927		
1868	c		1888	c	c	1908	c		1928	c	
1869	c	c	1889	c	c	1909			1929		
1870			1890			1910			1930		
1871			1891			1911			1931	c	c
1872			1892	c		1912	c		1932		
1873			1893			1913		c	1933		
1874			1894	c		1914	c	c	1934		
1875			1895		c	1915			1935		c
1876			1896			1916			1936		
1877	c		1897			1917	c		1937	c	
1878		c	1898			1918			1938		
1879	c	c[1]	1899	c	c	1919					

[1] Abundant in the Hawaiian Islands after not having been seen for several years.

and gives the same indications as the data for *C. lineata*, namely that there is a tendency for migrations to occur simultaneously in both continents.

The test of significance gives $\chi^2 = 8{\cdot}0$, which is significant at a level of about 1 in 200. The significance is, however, made considerably larger by the number of years with no records for either Continent. If one omits ten of these as possibly due to lack of evidence and only considers 30 years with outbreaks in neither Continent one still gets $\chi^2 = 4{\cdot}9$, which is significant at the 1 in 35 level.

TABLE 31.

Distribution of occurrence of *V. cardui* in Europe and N. America. A. Observed frequency; B. Frequency calculated on no correlation.

	A.—Observed frequency.			B.—Frequency calculated on no correlation.		
	In Europe	Not in Europe	Total	In Europe	Not in Europe	Total
In America . .	13	7	20	7·6	12·4	20
Not in America . .	14	40	54	19·4	34·6	54
Total . . .	27	47	74	27	47	74

If a record of the occurrence of large numbers of Painted Ladies in Hawaii in 1879 (a year of great abundance in Europe) may be taken as evidence of migration in North America, the results become even more significant with $\chi^2 = 6{\cdot}269$, which is significant at just above 1 in 100, even when ten of the years with no records are omitted.

The observations analysed for the two species therefore both show a tendency for large migrations to occur, or not to occur, simultaneously on both sides of the Atlantic.

This implies that, whatever the causes of extensive migration may be, they cannot be localised as independent happenings, but must be due to some widespread event, tending to vary in the same direction over areas covering nearly half the circumference of the earth.

XI. CORRELATIONS OF OCCURRENCE OF BRITISH IMMIGRANTS.

By G. F. COCKBILL.

About ten years ago, Williams commented on the appearance in entomological journals of such notes as " This year has been a good one for migrants," or alternatively, " Very few migrants have been reported this year," and asked if this represented a biological truth or a series of selected coincidences (Williams 1930b : 406).

There have been, in the literature, frequent allusions to the fact that when *V. cardui* is very abundant, *P. gamma* and *N. noctuella* also tended to be abundant, but beyond such remarks there is very little information of the activities of migrants in relation to one another.

Sufficient information has now been collected concerning the yearly abundances of thirty-five migrant species discussed in Section III of this report (p. 105) to allow correlations to be made and so to discover whether any species tend to occur or not to occur together.

The indices of abundance already described (p. 106) were used as a basis for the correlations.

Table 32, A, shows all the correlations of each of 35 species with all others. The species are arranged in four groups, Rhopalocera, Sphinges, Noctuae and an assortment of PYRALIDAE, GEOMETRIDAE and others labelled "Miscellaneous."

The correlations were taken over a period of 75 years from 1857 to 1931 in all but 5 cases. This period was decided upon because before 1857 records were scanty and after 1931 the records were of quite a different order due to the greatly increased numbers of records obtained through the Insect Immigration Committee of the S.E.U.S.S.

The five exceptions were of two kinds: (1) those species which were first recorded in Britain subsequent to 1857 were included for the period of their occurrence in Britain only. For this reason *D. plexippus* was considered over a period of 56 years and *L. albipuncta* over 64 years; (2) those species in which the early records were very scanty and vague were considered from the year when the records became fairly consistent. Thus *C. ambigua*, *P. napi* and *N. noctuella* were dealt with for 52 years.

The figures in the first column show the average correlations of each species with all others. Where 75 years are taken, the value of the correlation must be 0·23 or over to have a probability of 19 out of 20 that the result has not arisen by chance and a value of 0·30 or over to have a probability of 99 out of 100. Where 52 years are taken these values are increased to 0·27and 0·35 respectively.

For convenience of reference in Tables 17, 18 and 19 a lettered key is provided in each case.

Table 32, C, shows all the significant values indicated by + or — signs. The large signs show values at or above 1 in 100 level, and the small signs show values below these but significant at or above the 1 in 20 level. In this table, it can be seen that in section A, some species are highly positively correlated, e.g. *V. cardui, V. atalanta, C. croceus* and *C. hyale*, and others, namely the "Whites," are negatively correlated with other species.

In Section B (key), the correlations "Butterflies against Hawk-Moths," it can be seen that *M. stellatarum* shows a high positive correlation with *V. cardui, V. atalanta, C. croceus* and *C. hyale*, and that here again the Pierids show negative correlations.

In Section C, "Hawk-Moths against Hawk-Moths," there is very little relationship shown.

In Section D, "Butterflies against Noctuids," the Pierids again show negative correlations, and *P. gamma* shows a positive relationship with *V. cardui, V. atalanta, C. croceus* and *C. hyale.* The relationships of the other species are not very clear.

In Section E little is shown with "Noctuids against Hawk-Moths," but in Section F the "Noctuids against Noctuids," a general high positive correlation appears.

In Section G, the "Miscellaneous group against Butterflies," *N. noctuella* shows positive relationship with the *V. cardui* and *V. atalanta* group, and *U. pulchella* shows a negative relation with the butterflies. Section H, "Miscellaneous against Hawk-Moths," shows little except that in the case of *U. pulchella* the only significant values are negative.

In Section I, the Noctuids show a high positive correlation with *L. salicis* and *N. noctuella*, while in Section J, "Miscellaneous against Miscellaneous," *N. obstipata* and *S. sacraria* show a positive relationship and *U. pulchella* shows negative values.

These observations are summarised in tab. 32, B, where the average correlations for each section are shown. The highest average correlations occur between "Noctuids and Noctuids" and between "Miscellaneous and Noctuids" (Sections F and I respectively).

The total number of correlations is 595, of which 161 are negative values and 434 are positive. This preponderance of positive values is better shown in a frequency distribution of all correlations, fig. 59. The mean of all 595 correlations is + 0·12.

There are two possible explanations for this preponderance of positive values. It could be a biological fact resulting from a tendency for migrants to occur and to be absent together, *i.e.*, for there to be "good" and "bad" years for several migrant species simultaneously.

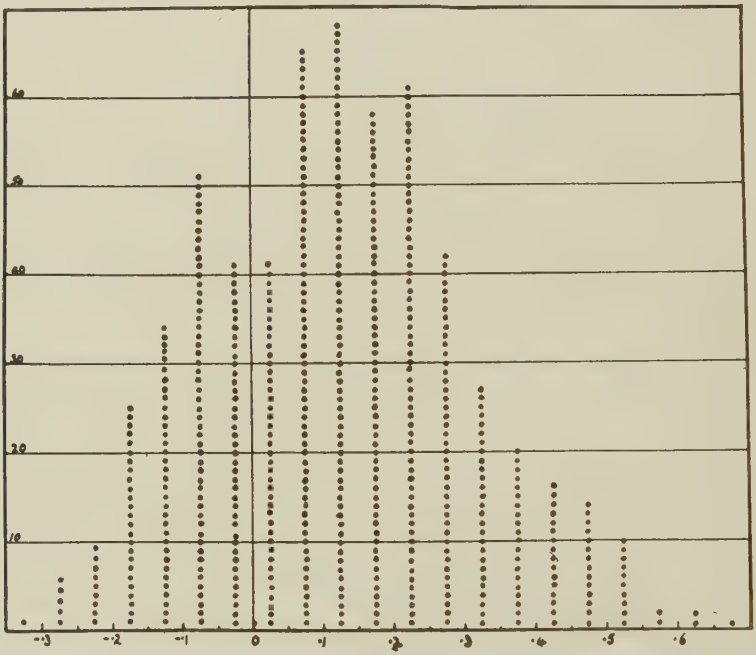


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Fig. 59.—Frequency distribution of the 595 intercorrelations of 35 British immigrant butterflies and moths.

It could also be due to irregularities in the evidence resulting from waves of interest in observers of migrant species. If for a few years migrants tended to be recorded and then for a few more to be overlooked altogether, they would show a positive correlation.

It is possible that both explanations are contributory. In order to reduce the effect of the second possibility, the correlation values were expressed as departures from the mean + 0·12 so that the positive bias was counteracted. The numbers of positive and negative values now become 291 and 304 respectively, which indicates an equal distribution about the mean.

Table 33, A, shows all correlations expressed as departure from the general mean (+ 0·12), the species now being arranged in order of their average correlation with all other species.

TABLE 32.

A. Intercorrelation of thirty-five British Immigrant Lepidoptera arranged in families. The first column is the average correlation of that species with all the other thirty-four species. B. Average correlation within and between families. C. Significant correlations large + and − significant at 1 : 100; small + and − significant at 1 : 20.

A

Rhopalocera	1. *D. plexippus* (56)	+0·01	*plex.*																																		
	2. *V. antiopa*	+0·08	−0·05	*ant.*																																	
	3. *V. cardui*	+0·18	−0·02	−0·01	*car.*																																
	4. *V. atalanta*	+0·09	−0·11	−0·04	+0·47	*atal.*																															
	5. *A. lathonia*	+0·08	−0·05	+0·28	−0·03	−0·22	*lath.*																														
	6. *C. croceus*	+0·19	+0·05	−0·09	+0·41	+0·49	+0·03	*croc.*																													
	7. *C. hyale*	+0·23	−0·07	+0·41	+0·33	+0·24	+0·30	+0·45	*hyal.*																												
	8. *P. daplidice*	+0·17	−0·05	+0·26	+0·17	−0·03	+0·39	+0·21	+0·29	*dap.*																											
	9. *P. brassicae*	+0·02	+0·28	+0·04	−0·03	+0·10	−0·11	+0·09	+0·04	+0·01	*brass.*																										
	10. *P. napi* (52)	+0·02	−0·04	+0·11	−0·22	+0·11	+0·12	−0·35	+0·25	+0·05	+0·22	*nap.*																									
	11. *P. rapae*	+0·00	−0·10	−0·15	−0·09	+0·20	−0·17	−0·14	−0·00	−0·20	+0·29	+0·52	*rap.*																								
SPHINGIDAE	12. *A. atropos*	+0·11	−0·06	−0·02	+0·18	+0·26	−0·00	+0·31	+0·23	+0·08	+0·15	+0·06	+0·08	*atr.*																							
	13. *H. convolvuli*	+0·11	+0·16	+0·23	+0·09	+0·20	−0·03	+0·27	+0·44	+0·14	+0·17	+0·15	+0·13	+0·24	*con.*																						
	14. *C. euphorbiae*	+0·05	+0·05	+0·19	−0·15	−0·16	+0·19	−0·08	+0·11	+0·20	+0·13	−0·05	−0·14	−0·03	+0·06	*euph.*																					
	15. *C. galii*	+0·08	+0·00	+0·24	−0·08	−0·10	+0·18	+0·09	+0·21	+0·22	−0·12	−0·16	−0·27	−0·00	+0·18	+0·30	*gal.*																				
	16. *H. celerio*	+0·11	+0·34	+0·12	+0·24	−0·29	+0·32	+0·09	+0·09	+0·25	+0·09	−0·18	−0·23	+0·08	+0·07	+0·08	+0·05	*cel.*																			
	17. *D. nerii*	+0·09	+0·25	+0·08	+0·13	+0·19	−0·03	+0·18	+0·18	+0·11	−0·14	+0·16	+0·10	+0·12	+0·02	+0·12	+0·12	+0·14	*nerii*																		
	18. *C. livornica*	+0·11	−0·08	−0·07	+0·33	−0·10	+0·09	+0·16	+0·12	+0·28	−0·19	−0·10	−0·14	+0·02	−0·05	−0·02	+0·21	+0·41	+0·05	*liv.*																	
	19. *M. stellatarum*	+0·21	−0·04	+0·05	+0·49	+0·38	+0·18	+0·48	+0·52	+0·19	+0·02	+0·11	+0·15	+0·33	+0·20	−0·16	−0·01	+0·08	+0·11	+0·21	*ste.*																
Noctuae	20. *A. ipsilon*	+0·21	−0·27	+0·21	+0·35	+0·22	−0·04	+0·32	+0·36	+0·29	−0·03	+0·14	+0·10	+0·28	+0·16	+0·03	+0·15	+0·21	+0·28	+0·12	+0·35	*ips.*															
	21. *P. saucia*	+0·19	−0·14	−0·07	+0·17	+0·17	+0·10	+0·36	+0·27	+0·24	−0·03	+0·08	+0·10	+0·23	+0·01	+0·19	+0·10	+0·27	+0·11	+0·22	+0·39	+0·63	*saucia*														
	22. *L. extranea*	+0·08	−0·04	−0·14	+0·25	+0·16	−0·16	+0·24	+0·16	+0·01	−0·17	−0·06	+0·16	+0·04	+0·00	−0·13	+0·04	−0·10	+0·11	+0·20	+0·17	+0·07	−0·03	*extr.*													
	23. *L. vitellina*	+0·14	−0·09	−0·03	+0·14	+0·26	−0·15	+0·32	+0·36	+0·08	−0·06	+0·11	+0·19	+0·27	+0·08	+0·25	−0·04	−0·10	+0·23	−0·08	+0·24	+0·43	+0·47	+0·24	*vit.*												
	24. *L. albipuncta* (64)	−0·11	−0·12	+0·26	−0·08	−0·23	+0·09	+0·09	+0·26	+0·38	−0·26	+0·17	−0·23	+0·06	+0·01	+0·21	+0·18	+0·11	−0·05	+0·12	+0·10	+0·21	+0·29	+0·01	+0·27	*albi.*											
	25. *C. ambigua* (52)	+0·20	−0·08	+0·23	+0·24	+0·22	−0·00	+0·09	+0·48	+0·13	−0·08	+0·31	+0·17	+0·21	+0·25	+0·25	+0·13	+0·05	±0·00	+0·00	+0·40	+0·36	+0·33	+0·02	+0·43	+0·66	*amb.*										
	26. *L. exigua*	+0·18	+0·10	+0·01	+0·54	+0·37	−0·07	+0·26	+0·25	+0·18	−0·01	+0·05	+0·14	+0·21	+0·09	−0·05	+0·12	+0·04	+0·15	+0·19	+0·34	+0·37	+0·15	+0·33	+0·22	−0·03	+0·38	*exig.*									
	27. *H. peltigera*	+0·09	+0·09	−0·18	+0·50	+0·07	−0·11	+0·29	−0·06	+0·15	−0·07	−0·12	−0·01	−0·15	−0·08	−0·15	+0·11	+0·20	+0·13	+0·51	+0·16	+0·05	−0·04	+0·48	−0·01	+0·08	+0·08	+0·53	*pelt.*								
	28. *H. armigera*	+0·18	−0·01	+0·16	+0·14	−0·14	+0·16	+0·24	+0·26	+0·42	−0·05	+0·12	−0·13	+0·23	+0·24	+0·20	+0·16	+0·13	+0·08	+0·11	+0·34	+0·33	+0·25	+0·09	+0·21	+0·45	+0·55	+0·27	+0·04	*arm.*							
	29. *P. gamma*	+0·12	+0·25	−0·09	+0·56	+0·46	−0·08	+0·40	+0·23	+0·09	−0·03	−0·19	+0·12	+0·31	+0·20	+0·04	+0·04	+0·18	+0·10	+0·15	+0·30	+0·25	+0·08	+0·07	+0·08	−0·07	+0·24	+0·37	+0·34	+0·05	*gam.*						
	30. *C. fraxini*	+0·06	+0·04	+0·49	−0·08	−0·06	+0·38	−0·15	+0·28	+0·35	−0·17	−0·16	−0·09	+0·08	+0·19	+0·24	+0·13	+0·22	+0·01	+0·09	−0·09	+0·10	+0·04	−0·08	+0·20	+0·16	+0·10	−0·09	−0·18	+0·11	−0·08	*frax.*					
Miscellaneous	31. *P. fluviata*	+0·17	−0·13	+0·04	+0·42	+0·06	+0·26	+0·39	+0·27	+0·14	+0·09	−0·10	+0·04	+0·14	+0·08	+0·06	+0·09	+0·30	−0·03	+0·20	+0·40	+0·31	+0·41	+0·20	+0·17	+0·22	+0·20	+0·22	+0·16	+0·29	−0·00	+0·06	*fluv.*				
	32. *R. sacraria*	+0·06	+0·06	−0·06	+0·18	−0·19	+0·17	+0·14	+0·10	+0·13	+0·03	+0·01	−0·05	+0·00	−0·09	−0·11	+0·04	+0·24	+0·04	+0·07	+0·17	+0·07	+0·15	+0·12	−0·06	+0·10	−0·16	+0·06	+0·07	+0·38	−0·09	−0·01	+0·48	*sacr.*			
	33. *D. pulchella*	−0·00	+0·26	+0·20	−0·18	−0·18	+0·24	+0·06	+0·15	+0·18	+0·11	−0·23	−0·09	−0·23	+0·13	−0·03	−0·08	+0·06	−0·10	+0·01	−0·12	+0·12	+0·12	−0·08	−0·13	+0·25	−0·08	−0·06	−0·08	−0·18	−0·10	+0·24	−0·21	−0·12	*pul.*		
	34. *L. salicis*	+0·19	−0·06	+0·12	+0·09	+0·03	+0·20	+0·16	+0·33	+0·24	+0·14	+0·19	−0·04	+0·27	+0·05	+0·12	+0·34	+0·08	+0·07	+0·28	+0·30	+0·50	+0·35	+0·06	+0·36	+0·38	+0·63	+0·13	+0·00	+0·30	+0·09	−0·01	+0·15	+0·03	+0·05	*sal.*	
	35. *N. noctuella* (52)	+0·16	−0·14	−0·11	+0·56	+0·40	+0·12	+0·50	+0·16	+0·18	+0·13	−0·13	−0·01	−0·06	−0·18	−0·12	+0·23	+0·02	+0·11	+0·41	+0·49	+0·25	+0·32	+0·46	+0·11	+0·11	−0·02	+0·50	+0·43	+0·18	−0·01	−0·27	+0·44	+0·21	−0·03	+0·34	*noct.*

General mean +0·12

+0·09				
+0·09	+0·10			
+0·10	+0·13	+0·19		
+0·10	+0·09	+0·14	+0·13	

B

ple.	*p.*																																		
ant.		*a.*																																	
car.			*c.*																																
ata.			+	*a.*																															
lat.				−	*l.*																														
cro.			+	+	−	*c.*																													
hya.		+				+	*h.*																												
dap.					+			*d.*																											
bra.					−				*b.*																										
nap.			−			−				*n.*																									
rap.		−			−	−		−			*r.*																								
atr.												*a.*																							
con.							+						*c.*																						
eup.			−	−							−			*e.*																					
gal.									−	−	−				*g.*																				
cel.				−						−	−					*c.*																			
ner.									−								*n.*																		
liv.									−		−					+		*l.*																	
ste.			+	+		+	+							−					*s.*																
ips.	−		+				+												+	*i.*															
sau.	−					+													+	+	*s.*														
ext.		−			−				−					−								*e.*													
vit.					−															+	+		*v.*												
alb.				−				+	−		−													*al.*											
amb.							+												+				+	+	*am.*										
exig.			+	+																						*e.*									
pelt.		−	+		−							−		−				+				+				+	*p.*								
arm.				−				+			−													+	+			*a.*							
gam.			+	+		+				−																+			*g.*						
frax.		+			+	−		+	−	−																	−			*fr.*					
fluv.			+			+													+		+				+						*f.*				
sacr.				−										−														+			+	*s.*			
pul.			−	−						−		−							−				−					−			−	−	*p.*		
sal.																				+	+		+	+	+									*s.*	
noct.			+	+		+							−					+	+			+				+	+			−	+				*n.*

C

A			
B	C		
D	E	F	
G	H	I	J

KEY

TABLE 33.

A. Intercorrelation of thirty-five British Immigrant Lepidoptera arranged in order of mean correlation with all others.
B. Mean intercorrelation in groups of five. C. Significant correlations as in table 35.

A

1. *D. pulchella*	−0·12	*pul.*																																		
2. *P. rapae*	−0·12	−0·21	*rap.*																																	
3. *D. plexippus*	−0·11	+0·14	−0·22	*plex.*																																
4. *P. brassicae*	−0·10	−0·01	+0·17	+0·16	*brass.*																															
5. *P. napi*	−0·10	−0·35	+0·40	−0·16	+0·10	*napi*																														
6. *C. euphorbiae*	−0·07	−0·15	−0·26	−0·07	+0·01	−0·17	*euph.*																													
7. *C. fraxini*	−0·06	+0·12	−0·21	−0·08	−0·29	−0·28	+0·12	*frax.*																												
8. *R. sacraria*	−0·06	−0·24	−0·17	−0·06	−0·09	−0·11	−0·23	−0·13	*sacr.*																											
9. *A. lathonia*	−0·04	+0·12	−0·29	−0·17	−0·23	0	+0·07	+0·26	+0·05	*lath.*																										
10. *V. antiopa*	−0·04	+0·08	−0·27	−0·17	−0·08	−0·01	+0·07	+0·37	−0·18	+0·16	*ant.*																									
11. *L. extranea*	−0·04	−0·20	+0·04	−0·16	−0·29	−0·18	−0·25	−0·20	0	−0·28	−0·26	*extr.*																								
12. *C. galii*	−0·04	−0·20	−0·39	−0·12	−0·24	−0·28	+0·18	+0·01	−0·08	+0·06	+0·12	−0·08	*gal.*																							
13. *H. peltigera*	−0·03	−0·20	−0·13	−0·03	−0·19	−0·24	−0·27	−0·30	−0·05	−0·23	−0·30	+0·36	−0·01	*pelt.*																						
14. *D. nerii*	−0·03	−0·22	−0·02	+0·13	−0·26	+0·04	0	−0·11	−0·08	−0·15	−0·04	−0·01	0	+0·01	*ner.*																					
15. *V. atalanta*	−0·03	−0·30	+0·08	−0·23	−0·02	−0·01	−0·28	−0·18	−0·31	−0·34	−0·16	+0·04	−0·22	−0·05	+0·07	*atal.*																				
16. *C. livornica*	−0·01	−0·02	−0·26	−0·20	−0·31	−0·22	−0·14	−0·03	−0·05	−0·03	−0·19	+0·08	+0·09	+0·39	−0·09	−0·22	*liv.*																			
17. *H. celerio*	−0·01	−0·06	−0·35	+0·22	−0·03	−0·30	−0·04	+0·10	+0·12	+0·20	0	−0·22	−0·07	+0·08	+0·02	−0·41	+0·29	*cel.*																		
18. *L. albipuncta*	−0·01	+0·13	−0·35	−0·24	−0·38	+0·05	+0·09	+0·04	−0·02	−0·03	+0·14	−0·11	+0·06	−0·20	−0·17	−0·35	0	−0·01	*albi.*																	
19. *A. atropos*	−0·01	−0·35	−0·04	−0·18	+0·03	−0·06	−0·15	−0·04	−0·12	−0·12	−0·14	−0·08	−0·12	−0·27	0	+0·14	−0·10	−0·04	−0·06	*atr.*																
20. *H. convolvuli*	−0·01	+0·01	+0·01	+0·04	+0·05	+0·03	−0·06	+0·07	−0·21	−0·15	+0·11	−0·12	+0·06	−0·20	−0·10	+0·08	−0·17	−0·05	−0·11	+0·12	*con.*															
21. *P. gamma*	0	−0·22	0	−0·07	−0·15	−0·31	−0·08	−0·20	−0·21	−0·20	−0·21	−0·05	−0·08	+0·22	−0·02	+0·34	+0·03	+0·06	−0·19	+0·19	+0·08	*gam.*														
22. *L. vitellina*	+0·02	−0·25	+0·07	−0·21	−0·18	−0·01	+0·13	+0·08	−0·18	−0·27	−0·15	+0·12	−0·16	−0·13	+0·11	+0·14	−0·20	−0·22	+0·15	+0·15	−0·04	−0·04	*vit.*													
23. *N. noctuella*	+0·04	−0·15	−0·13	−0·26	+0·01	−0·25	−0·24	−0·39	+0·09	0	−0·23	+0·34	+0·11	+0·31	−0·01	+0·28	+0·29	−0·10	−0·01	−0·18	−0·30	−0·13	−0·01	*noct.*												
24. *P. fluviata*	+0·05	−0·33	−0·08	−0·25	−0·03	−0·22	−0·06	−0·06	+0·36	+0·14	−0·08	+0·08	−0·03	+0·04	−0·15	−0·06	+0·08	+0·18	+0·10	+0·02	−0·04	−0·12	+0·05	+0·32	*fluv.*											
25. *P. daplidice*	+0·05	+0·06	−0·32	−0·07	−0·11	−0·07	+0·08	+0·23	+0·01	+0·27	+0·14	−0·11	+0·10	+0·03	−0·01	−0·15	+0·16	+0·13	+0·26	−0·04	+0·02	−0·03	−0·04	+0·06	+0·02	*dap.*										
26. *H. armigera*	+0·06	−0·30	−0·25	−0·13	−0·17	0	+0·08	−0·01	+0·26	+0·04	+0·04	−0·03	+0·04	−0·08	−0·04	−0·26	−0·01	+0·01	+0·33	+0·11	+0·12	−0·07	+0·09	+0·06	+0·17	+0·30	*arm.*									
27. *V. cardui*	+0·06	−0·30	−0·21	−0·14	−0·15	−0·34	−0·27	−0·20	+0·06	−0·15	−0·13	+0·13	−0·20	+0·38	+0·01	+0·35	+0·21	+0·12	−0·20	+0·06	−0·03	+0·44	+0·02	+0·44	+0·30	+0·05	+0·02	*car.*								
28. *L. exigua*	+0·06	−0·18	+0·02	−0·02	−0·13	−0·07	−0·17	−0·21	−0·06	−0·19	−0·11	+0·21	0	+0·41	+0·03	+0·25	+0·07	−0·08	−0·09	+0·09	−0·03	+0·25	+0·10	+0·38	+0·10	+0·06	+0·15	+0·42	*exig.*							
29. *P. saucia*	+0·07	±0	−0·02	−0·26	−0·15	−0·04	+0·07	−0·08	+0·03	−0·02	−0·19	−0·15	−0·02	−0·16	−0·01	+0·05	+0·10	+0·15	+0·17	+0·11	−0·11	−0·04	+0·35	+0·20	+0·29	+0·12	+0·13	+0·05	+0·03	*sauc.*						
30. *L. salicis*	+0·07	−0·07	−0·16	−0·18	+0·02	+0·07	0	−0·13	−0·09	+0·08	0	−0·06	+0·22	−0·12	−0·05	−0·09	+0·16	−0·04	+0·26	+0·15	−0·07	−0·03	+0·24	+0·22	+0·03	+0·12	+0·18	−0·03	+0·01	+0·23	*sal.*					
31. *C. croceus*	+0·07	−0·06	−0·26	−0·07	−0·03	−0·47	−0·20	−0·27	+0·02	−0·09	−0·21	+0·12	−0·03	+0·17	+0·06	+0·37	+0·04	−0·03	−0·03	+0·19	+0·15	+0·28	+0·20	+0·38	+0·27	+0·09	+0·12	+0·29	+0·14	+0·24	+0·04	*croc.*				
32. *C. ambigua*	+0·08	−0·20	+0·05	−0·20	−0·20	+0·19	+0·13	−0·02	−0·28	−0·12	+0·11	−0·10	+0·01	−0·04	−0·12	+0·10	−0·12	−0·07	+0·54	+0·09	+0·13	+0·12	+0·31	−0·14	+0·08	+0·01	+0·43	+0·12	+0·26	+0·21	+0·51	+0·07	*amb.*			
33. *M. stellatarum*	+0·09	−0·24	+0·03	−0·16	−0·10	−0·01	−0·28	−0·21	+0·05	+0·06	−0·07	+0·05	−0·13	+0·04	−0·01	+0·26	+0·09	−0·04	−0·02	+0·21	+0·08	+0·18	+0·12	+0·37	+0·28	+0·07	+0·22	+0·37	+0·22	+0·27	+0·13	+0·36	+0·28	*stel.*		
34. *A. ipsilon*	+0·09	0	−0·02	−0·39	−0·15	+0·02	−0·09	−0·02	−0·05	−0·16	+0·09	−0·05	+0·03	−0·07	+0·16	+0·10	0	+0·09	+0·09	+0·16	+0·04	+0·13	+0·31	+0·13	+0·19	+0·17	+0·21	+0·24	+0·20	+0·51	+0·38	+0·30	+0·24	+0·23	*ips.*	
35. *C. hyale*	+0·11	+0·03	−0·12	−0·19	−0·08	+0·13	−0·01	+0·16	−0·02	+0·18	+0·29	+0·04	+0·09	−0·18	+0·06	+0·12	0	−0·03	+0·14	+0·11	+0·32	+0·11	+0·14	+0·04	+0·15	+0·17	+0·14	+0·21	+0·13	+0·15	+0·21	+0·33	+0·36	+0·40	+0·24	*hyal.*

B

−0·02						
−0·12	+0·05					
−0·19	−0·14	+0·00				
−0·13	−0·03	−0·07	−0·01			
−0·14	−0·04	+0·05	+0·02	+0·01		
−0·13	−0·05	+0·03	+0·06	+0·17	+0·12	
−0·20	−0·04	+0·04	+0·09	+0·17	+0·24	+0·27

C

pul.	*p.*																																		
rap.		*r.*																																	
plex.			*p.*																																
brass.				*b.*																															
napi	−	+			*n.*																														
euph.		−				*e.*																													
frax.				−	−		*fr.*																												
sacr.	−					−		*s.*																											
lath.		−		−			+		*l.*																										
ant.		−					+			*a.*																									
extr.				−		−			−	−	*e.*																								
gal.		−		−	−							*g.*																							
pelt.						−	−		−	−	+		*p.*																						
ner.				−										*n.*																					
atal.	−					−		−	−						*a.*																				
liv.		−		−									+			*l.*																			
cel.		−			−										−	+	*c.*																		
albi.		−		−											−			*a.*																	
atr.	−												−						*at.*																
con.																				*c.*															
gam.					−										+						*g.*														
vit.	−								−													*v.*													
noct.							−				+		+		+	+				−			*n.*												
fluv.	−							+															+	*fl.*											
dap.		−					+		+									+							*d.*										
arm.	−	−						+							−			+							+	*a.*									
card.	−				−	−							+		+						+		+	+			*c.*								
exig.													+		+						+		+				+	*e.*							
sauc.			−																			+		+					*s.*						
sal.																		+				+							+	*sal.*					
croc.		−			−		−								+						+		+	+			+		+		*c.*				
amb.								−										+				+				+				+		*a.*			
stel.	−					−									+								+	+			+		+		+	+	*s.*		
ips.			−																			+					+		+	+			+	*i.*	
hyal.									+											+											+	+	+	+	*h.*

A						
B	C					
D	E	F				
G	H	I	J			
K	L	M	N	O		
P	Q	R	S	T	U	
V	W	X	Y	Z	AA	BB

KEY.

TABLE 34.

A. Intercorrelation of thirty-five British Immigrant Lepidoptera provisionally arranged in seven groups which are in general positively correlated within a group but negatively correlated outside. B. Mean correlations within and between groups: the number in the right-hand bottom corner is the number of intercorrelations on which the average is based.

A

1.	*C. hyale*	*hyal.*																																		
	C. croceus	+0·33	*croc.*																																	
	P. daplidice	+0·17	+0·09	*dap.*																																
	V. cardui	+0·21	+0·29	+0·05	*car.*																															
	M. stellatarum	+0·40	+0·36	+0·07	+0·37	*stel.*																														
	A. ipsilon	+0·24	+0·30	+0·17	+0·24	+0·23	*ips.*																													
	C. ambigua	+0·36	+0·07	+0·01	+0·12	+0·28	+0·24	*amb.*																												
	P. saucia	+0·15	+0·24	+0·12	+0·05	+0·27	+0·51	+0·21	*sau.*																											
	L. exigua	+0·13	+0·14	+0·06	+0·42	+0·22	+0·20	+0·26	+0·03	*exig.*																										
	H. armigera	+0·14	+0·12	+0·30	+0·03	+0·22	+0·21	+0·43	+0·13	+0·15	*arm.*																									
	L. vitellina	+0·14	+0·20	−0·04	+0·02	+0·12	+0·31	+0·31	+0·35	+0·10	+0·09	*vit.*																								
	P. gamma	+0·11	+0·28	−0·03	+0·44	+0·18	+0·13	+0·12	−0·04	+0·25	−0·07	−0·04	*gam.*																							
	P. fluviata	+0·15	+0·27	+0·02	+0·30	+0·28	+0·19	+0·08	+0·29	+0·10	+0·17	+0·05	−0·12	*fluv.*																						
	L. salicis	+0·21	+0·04	+0·12	−0·03	+0·18	+0·38	+0·51	+0·23	+0·01	+0·18	+0·24	−0·03	+0·03	*sal.*																					
	N. noctuella	+0·04	+0·38	+0·06	+0·44	+0·37	+0·13	−0·14	+0·20	+0·38	+0·06	−0·01	−0·13	+0·32	+0·22	*noct.*																				
2.	*C. livornica*	0	+0·04	+0·16	+0·21	+0·09	0	−0·12	+0·10	+0·07	−0·01	−0·20	+0·03	+0·08	+0·16	+0·29	*liv.*																			
	H. celerio	−0·03	−0·03	+0·13	+0·12	−0·04	+0·09	−0·07	+0·15	−0·08	+0·01	−0·22	+0·06	+0·18	−0·04	−0·10	+0·29	*cel.*																		
	A. atropos	+0·11	+0·19	−0·04	+0·06	+0·21	+0·16	+0·09	+0·11	+0·09	+0·11	+0·15	+0·19	+0·02	+0·15	−0·18	−0·10	−0·04	*atr.*																	
	L. albipuncta	+0·14	−0·03	+0·26	−0·20	−0·02	+0·09	+0·54	+0·17	−0·09	+0·33	+0·15	−0·19	+0·10	+0·26	−0·01	0	−0·01	−0·06	*albi.*																
	V. atalanta	+0·12	+0·37	−0·15	+0·35	+0·26	+0·10	+0·10	+0·05	+0·25	−0·26	+0·14	+0·34	−0·06	−0·09	+0·28	−0·22	−0·41	+0·14	−0·35	*at.*															
3.	*H. convolvuli*	+0·32	+0·15	+0·02	−0·03	+0·08	+0·04	+0·13	−0·11	−0·03	+0·12	−0·04	+0·08	−0·04	−0·07	−0·30	−0·17	−0·05	+0·12	−0·11	+0·08	*con.*														
4.	*L. extranea*	+0·04	+0·12	−0·11	+0·13	+0·05	−0·05	−0·10	−0·15	+0·21	−0·03	+0·12	−0·05	+0·08	−0·06	+0·34	+0·08	−0·22	−0·08	−0·11	+0·04	−0·12	*extr.*													
	H. peltigera	−0·18	+0·17	+0·03	+0·38	+0·04	−0·07	−0·04	−0·16	+0·41	−0·08	−0·13	+0·22	+0·04	−0·12	+0·31	+0·39	−0·08	−0·27	−0·20	−0·05	−0·20	+0·36	*pelt.*												
5.	*R. sacraria*	−0·02	+0·02	+0·01	+0·06	+0·05	−0·05	−0·28	+0·03	−0·06	+0·26	−0·18	−0·21	+0·36	−0·09	+0·09	−0·05	+0·12	−0·12	−0·02	−0·31	−0·21	0	−0·05	*sacr.*											
6.	*D. nerii*	+0·06	+0·06	−0·01	+0·01	−0·01	+0·16	−0·12	−0·01	+0·03	−0·04	+0·11	−0·02	−0·15	−0·05	−0·01	−0·09	+0·02	0	−0·17	+0·07	−0·10	−0·01	+0·01	−0·08	*ner.*										
7.	*V. antiopa*	+0·29	−0·21	+0·14	−0·13	−0·07	+0·09	+0·11	−0·19	−0·11	+0·04	−0·15	−0·21	−0·08	0	−0·22	−0·19	0	−0·14	+0·14	−0·16	+0·11	−0·26	−0·30	−0·18	−0·04	*ant.*									
	A. lathonia	+0·18	−0·09	+0·27	−0·15	+0·06	−0·16	−0·12	−0·02	−0·19	+0·04	−0·27	−0·20	+0·14	+0·08	0	−0·03	+0·20	−0·12	−0·03	−0·34	−0·15	−0·28	−0·23	+0·05	−0·15	+0·16	*lath.*								
	C. euphorbiae	−0·01	−0·20	+0·08	−0·27	−0·28	−0·09	+0·13	+0·07	−0·17	+0·08	+0·13	−0·08	−0·06	0	−0·24	−0·14	−0·04	−0·15	+0·09	−0·28	−0·06	−0·25	−0·27	−0·23	0	+0·07	+0·07	*euph.*							
	C. galii	+0·09	−0·03	+0·10	−0·20	−0·13	+0·03	+0·01	−0·02	0	+0·04	−0·16	−0·08	−0·03	+0·22	+0·11	+0·09	−0·07	−0·12	+0·06	−0·22	+0·06	−0·08	−0·01	−0·08	0	+0·12	+0·06	+0·18	*gal.*						
	C. fraxini	+0·16	−0·27	+0·23	−0·20	−0·21	−0·02	−0·02	−0·08	−0·21	−0·01	+0·08	−0·20	−0·06	−0·13	−0·39	−0·03	+0·10	−0·04	−0·04	−0·18	+0·07	−0·20	−0·30	−0·13	−0·11	+0·37	+0·26	+0·12	+0·01	*frax.*					
8.	*P. brassicae*	−0·08	−0·03	−0·11	−0·15	−0·10	−0·15	−0·20	−0·15	−0·13	−0·17	−0·18	−0·15	−0·03	−0·02	+0·01	−0·31	−0·03	+0·03	−0·38	−0·02	+0·05	−0·29	−0·19	−0·09	−0·26	−0·08	−0·23	+0·01	−0·24	−0·29	*brass.*				
	P. napi	+0·13	−0·47	−0·07	−0·34	−0·01	+0·02	+0·19	−0·04	−0·07	0	−0·01	−0·31	−0·22	+0·07	−0·25	−0·22	−0·30	−0·06	+0·05	−0·01	+0·03	−0·18	−0·24	−0·11	+0·04	−0·01	0	−0·17	−0·28	−0·28	+0·10	*napi*			
	P. rapae	−0·12	−0·26	−0·32	−0·21	+0·03	−0·02	+0·05	−0·02	+0·02	−0·25	+0·07	0	−0·08	−0·16	−0·13	−0·26	−0·35	−0·04	−0·35	+0·08	+0·01	+0·04	−0·13	−0·17	−0·02	−0·27	−0·29	−0·26	−0·39	−0·21	+0·17	+0·40	*rap.*		
9.	*D. plexippus*	−0·19	−0·07	−0·07	−0·14	−0·16	−0·39	−0·20	−0·26	−0·02	−0·13	−0·21	−0·07	−0·25	−0·18	−0·26	−0·20	+0·22	−0·18	−0·24	−0·23	+0·04	−0·16	−0·03	−0·06	+0·13	−0·17	−0·17	−0·07	−0·12	−0·08	+0·16	−0·16	−0·22	*plex.*	
	D. pulchella	+0·03	−0·06	+0·06	−0·30	−0·24	0	−0·20	±0	−0·18	−0·30	−0·25	−0·22	−0·33	−0·07	−0·15	−0·02	−0·06	−0·35	+0·13	−0·30	+0·01	−0·20	−0·20	−0·24	−0·22	+0·08	+0·12	−0·15	−0·20	+0·12	−0·01	−0·35	−0·21	+0·14	*pul.*

B

1	+0·12 105								
2	+0·07 75	−0·08 10							
3	+0·02 15	−0·03 5	—						
4	+0·05 30	−0·05 10	−0·16 2	+0·36 1					
5	0 15	−0·08 5	−0·21 1	−0·03 2	—				
6	0 15	−0·03 5	−0·10 1	0 2	−0·08 1	—			
7	−0·05 75	−0·07 25	+0·01 5	−0·22 10	−0·11 5	−0·06 5	+0·14 10		
8	−0·10 45	−0·15 15	+0·03 3	−0·17 6	−0·12 3	−0·08 3	−0·20 15	+0·22 3	
9	−0·16 30	−0·13 10	+0·03 2	−0·15 4	−0·15 2	−0·05 2	−0·07 10	−0·13 6	+0·14 1
	1	2	3	4	5	6	7	8	9

It seemed likely that some species would fall into groups and that others would be isolated cases, on the axiom that things like another must be themselves alike, but things unlike another need have no relation to one another.

By arranging the species in order of their average correlation with all other species, an indication was given of the arrangement of the groups.

The disposition of the signs can be seen from Table 33, B, where the average intercorrelations of the species taken in fives are shown. Those species in Section A show an average positive correlation, but wherever else they occur, *i.e.* in Sections B, D, G, K, P and V the average correlation is negative.

From Table 33, C, a clear-cut group is seen in Sections O, T, Z, U, AA, and BB, consisting of the species from *P. gamma* to *C. hyale* inclusive, within which there are high positive correlations but which show negative correlations with other species.

An attempt was then made to form the remaining species into groups according to their relationship with themselves and with the first group.

Table 34, A, shows the species provisionally arranged in seven groups. Group 1, already defined, consists of fifteen species which are positively intercorrelated but negatively correlated with species outside the group.

Group 2 is a somewhat unsatisfactory group of five species, the members of which show positive correlations with Group 1 but show little or no relation between themselves, except in the cases of *H. celerio* and *C. livornica*, where a significant correlation is shown. *V. atalanta* is highly negatively correlated with all but *A. atropos* in the group.

Groups 3, 4, 5 and 6 consist of species which show negative relationship with other groups. In Group 4, *L. unipuncta* and *N. peltigera* are taken together since they are highly positively correlated with themselves and with *N. noctuella*, and show somewhat similar relationships with other species.

In Group 7 are five species which form a group much less evident than Group 1 but which show more interrelationships than do other species outside Group 1.

Group 8 is another clear-cut group consisting of the three " Whites." These species are markedly negatively correlated with other species, but show their highest positive correlation between themselves.

Group 9 consists of two species negatively correlated with other species but showing a slight positive correlation between themselves.

Groups 8 and 9, although both negatively correlated with other species, show no interrelation between themselves.

Table 34, B, shows the average correlations of the species within the groups. In cases where there is only one species within the group, there is no average correlation within that group, and the appropriate space is left blank.

It would be expected with almost 600 correlations that, by chance, there would be 30 values significant at 1 in 20 level, and 6 at the 1 in 100 level. Actually as seen from Table 32, C, there are 118 values at the 1 in 20 level, and of these 52 are significant at 1 in 100 level.

This result is in itself evidence of the real biological nature of the values.

Fluctuations in abundance of correlated groups.

The material was available for a study of the question of periodicity in migrant Lepidoptera. Since the species tended to form groups, the group was taken as a unit. It was considered that the " good " and " bad " years within a single group would be accentuated by this means.

Table 35 shows the average abundance indices of the principal Groups 1, 2, 7 and of all species from 1857 to 1931 (allowance being made for species of shorter duration).

TABLE 35.

Mean annual abundance of certain groups of associated immigrants, and of all immigrants, 1857–1931.

	0	1	2	3	4	5	6	7	8	9
Group 1 (15 species)										
1850								2·8	3·6	3·1
1860	1·5	1·5	1·5	1·2	1·3	2·8	1·4	2·5	3·2	2·0
1870	1·9	1·6	2·0	1·0	1·0	1·5	1·5	2·4	2·2	2·3
1880	1·5	1·3	1·4	2·2	2·4	1·8	1·6	1·1	1·9	2·1
1890	1·7	1·5	3·5	3·1	2·7	2·2	1·5	2·5	2·8	4·0
1900	4·4	3·3	2·6	2·5	2·3	1·1	3·2	1·6	2·3	1·2
1910	1·1	2·3	2·5	2·3	1·5	1·5	1·0	1·9	1·5	1·7
1920	2·3	2·3	2·1	1·9	1·6	1·1	2·2	1·6	3·3	2·0
1930	1·7	2·3								
Group 2 (5 species)										
1850								3·3	3·3	2·8
1860	2·8	1·3	2·5	1·3	2·0	3·5	2·0	3·3	4·0	3·0
1870	3·5	3·0	3·0	2·3	1·8	2·0	3·0	3·8	3·8	2·5
1880	2·0	2·0	2·2	2·6	3·0	3·2	2·4	2·2	2·8	2·0
1890	1·6	2·0	3·4	3·0	3·4	3·6	3·0	2·6	3·2	3·8
1900	4·2	3·0	3·4	2·8	2·6	3·0	3·2	1·4	2·8	2·8
1910	1·6	2·8	3·2	2·8	2·6	2·0	1·4	2·2	1·8	1·6
1920	3·2	2·2	2·4	2·0	2·8	2·0	1·8	2·2	2·4	1·8
1930	2·6	2·8								
Group 7 (5 species)										
1850								3·0	3·4	3·2
1860	2·4	1·2	1·0	1·2	1·6	2·2	1·8	1·6	3·8	1·6
1870	3·0	2·4	4·2	1·8	2·2	2·4	2·2	1·4	2·2	1·2
1880	3·2	1·6	1·8	1·8	1·4	1·6	1·4	2·0	2·8	3·0
1890	1·4	1·0	1·8	1·8	1·4	2·4	2·4	1·4	1·6	1·8
1900	2·4	2·6	1·8	1·4	1·4	2·0	1·4	1·2	1·2	1·4
1910	1·6	1·8	1·2	1·2	1·4	1·6	1·2	1·8	1·6	1·6
1920	1·0	2·0	1·6	1·6	1·8	1·4	1·4	1·0	1·6	1·8
1930	1·4	1·4								
All species (35 species)										
1850								2·8	3·2	2·8
1860	1·7	1·6	1·7	1·4	1·6	2·4	1·4	2·2	2·9	2·0
1870	2·0	2·0	2·3	1·4	1·6	1·9	1·9	2·3	2·0	1·8
1880	1·8	1·7	1·6	1·8	2·0	2·1	1·7	1·7	2·1	1·9
1890	1·6	1·8	3·0	2·5	2·2	2·2	2·1	2·3	2·5	3·0
1900	3·5	2·7	2·2	2·2	2·1	1·4	2·8	1·6	2·0	1·6
1910	1·4	2·3	2·2	2·0	1·7	1·6	1·4	2·1	1·6	1·8
1920	2·2	2·0	2·0	2·0	1·8	1·4	2·1	1·5	2·6	1·7
1930	1·9	2·0								

A 10-year running mean was calculated from these averages and shown in Table 36.

Fig. 60 shows a histogram of the average abundance indices of Groups 1, 2, 7 and of all species, together with their respective 10-year running means in broken lines. The 10-year running mean of Group 1 shows a peak around the year 1900, but otherwise the average is fairly uniform.

Group 2 10-year mean also shows a peak about the year 1908, with a minor peak at about the year 1868.

Group 7 has a slight peak around the year 1872, with a general falling off in abundances to 1931.

TABLE 36.

Ten-year running mean of average annual abundance of certain groups of associated immigrants, and of all immigrants, 1857–1931.

Group	1857–1866	1862–1871	1867–1876	1872–1881	1877–1886	1882–1891	1887–1896	1892–1901	1897–1906	1902–1911	1907–1916	1912–1921	1917–1926	1922–1931
1.	2·1	1·9	1·8	1·7	1·9	1·7	2·0	3·0	2·9	2·0	1·7	1·9	1·9	2·0
2.	2·5	2·8	2·9	2·6	2·8	2·4	2·7	3·3	3·2	2·6	2·3	2·3	2·2	2·3
7.	2·1	2·0	2·5	2·2	1·8	1·8	2·0	2·0	1·8	1·5	1·4	1·5	1·6	1·5
All species	2·1	2·0	2·0	2·0	2·0	1·8	2·1	2·6	2·5	2·0	1·8	1·9	1·9	1·9

The 10-year running mean of all species shows a steady curve with a slight peak at about 1900.

It appears evident from the diagrams that there is no indication of an 11-year cycle, that could fit in with the Sun Spot Cycle, and also that the records show no appreciable falling off or increase during the years 1857–1931. Even during the years 1914–1918, when one might have expected a decided lack of interest in the activities of insects, the average recorded abundances show no evidence of it.

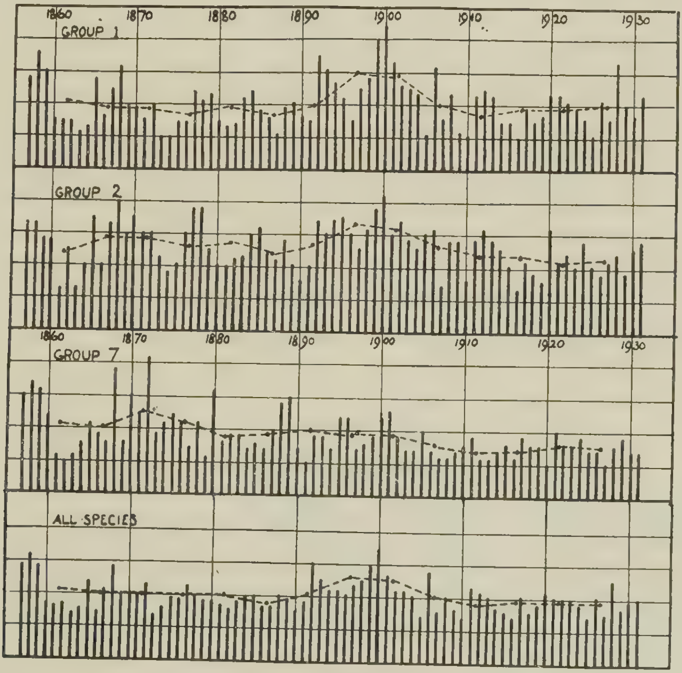

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FIG. 60.—Average annual frequency, and 10 years' running mean of the same, for certain groups of associated immigrants, and for all the 35 immigrants studied.

Relationship between the groups and the geographical range of the species.

It is a feature of migrant Lepidoptera that they are widespread in their distribution. In most cases, the British immigrants range from N. Europe to N. Africa. However, there are a few species to be mentioned which are more restricted in their range. It can be shown that where a species has a less ubiquitous range, its position in the groups can often be accounted for, and that where species have a common source, they are related in the same group.

Thus *D. plexippus*, the only immigrant from America and from the west, shows a decided negative relationship with other species (Table 19). It is doubtfully placed with *D. pulchella* in a group only since this latter species has a similar relationship with other species, and there is a slight positive correlation between the two. The probability is that the factors which determine the arrival of *D. plexippus* in Britain are of quite a different nature from those determining the arrival of migrants from the east and south.

In Group 8, the Pierids show a positive relationship between themselves. This could be accounted for by the fact that the species are indigenous in Britain, and that their migrations originate from a common source. Accumulated evidence lends weight to the view that they originate in northern Europe.

In Group 7, the only species with a limited distribution appear to be *V. antiopa* and *C. fraxini*. These species show a significant positive intercorrelation. It is noteworthy that migrations of *V. antiopa* originate in Scandinavia and that *C. fraxini* is distributed over northern Europe and does not appear south of N. Italy. This point is reflected in the number of negative correlations shown by these species with members of Group 1, which contains species from the Mediterranean region and N. Africa.

In Group 1 appear the butterflies from the Mediterranean region, namely *C. hyale*, *C. croceus*, *V. cardui* and *P. daplidice*. In addition, *M. stellatarum*, a day-flying hawk-moth, is included. *V. atalanta* is also a Mediterranean species and shows positive correlations with Group 1. However, the average correlation of this species with all others (— 0·03) is below the lowest average of Group 1, and excludes it from this Group.

The distribution of the other species is too general to permit a more detailed classification at this stage.

XII. Suggested classification of density of migration.

By C. B. Williams.

In describing migrations observers have used various terms to indicate the density of the flight "thin," "sparse," "copious," "obvious," "thick," "snow storm" etc. etc. Others have stated the number of butterflies present at any one time on a given area, or, more frequently, the numbers passing across a front of a given width in a given time. The last is the easiest figure to obtain with any accuracy.

It seems desirable to have some simple scale of grading by which the whole range from very thin to very thick flights could be classified. For this one must first have some idea of the extreme limits of density which such a scale must cover.

I have myself produced evidence of migration of white butterflies in Harpenden from observing about 20 butterflies passing in 20 minutes over a front of about 100 yards. Such a movement would only be noticed by very careful watch by an expert observer and even then the evidence only becomes convincing when several periods of 20 minutes' watching have given similar results. It is undoubtedly near the lower limit of demonstration.

At the other end of the scale are snowstorm migrations in which the butterflies are too numerous to count even on a short front. In one flight of *Andronymus neander* in East Africa which was just above the limit of accurate counting I estimated at the peak flight that 500 per minute were crossing a 22 yards front, or about 2300 per minute on a 100 yards front. Denser flights than these are known. It seems therefore that the numbers passing per 100 yards per minute are likely to range from 1 to perhaps 10,000 insects. It was decided that a convenient classification of this range would be a geometric one with seven groups with the following mean numbers :—1 : 4·6 : 21·5 : 100 : 464 : 2154 : 10,000 (Table 37).

TABLE 37.

Proposed classification of density of migrations with numbers that would be observed on fronts of different lengths in different periods of time.

Density	Width of front in yards[1]	Duration of observation in minutes				
		1	5	10	15	20
I	100	1–2	2–11	5–21	7–32	9–43
	50	1	1–5	2–10	3–16	5–21
	25	—	1–2	1–5	2–8	3–10
	10	—	1	1–2	1–3	1–4
	5	—	—	1	1	1–2
II	100	3–10	12–50	22–100	33–150	44–200
	50	1–5	6–25	11–50	17–75	22–100
	25	1–2	3–12	6–25	9–37	11–50
	10	1	2–5	3–10	4–15	5–20
	5	—	1–2	1–5	2–7	3–10
III	100	11–46	51–232	101–464	151–696	201–928
	50	6–23	26–116	51–232	76–348	101–464
	25	3–11	13–58	26–116	38–174	51–232
	10	1–4	6–23	11–46	16–69	21–92
	5	1–2	3–11	6–23	8–34	11–46
IV	100	47–215	233–1,077	465–2,154	697–3,231	929–4,308
	50	24–107	117–538	233–1,077	349–1,615	465–2,154
	25	12–53	59–269	117–538	175–807	233–1,077
	10	5–21	24–107	47–215	70–323	93–430
	5	3–10	12–53	24–107	35–161	47–215
V	100	216–1,000	1,078–5,000	2,155–10,000	3,232–15,000	4,309–20,000
	50	108–500	539–2,500	1,078–5,000	1,616–7,500	2,155–10,000
	25	54–250	270–1,250	539–2,500	808–3,750	1,078–5,000
	10	22–100	108–500	216–1,000	324–1,500	431–2,000
	5	11–50	54–250	108–500	162–750	216–1,000
VI	100	1,001–4,640	5,001–23,200	10,001–46,400	15,001–69,600	20,001–92,800
	50	500–2,320	2,501–11,600	5,001–23,200	7,501–34,800	10,001–46,400
	25	251–1,160	1,251–5,800	2,501–11,600	3,751–17,400	5,001–23,200
	10	101–464	501–2,320	1,001–4,640	1,501–6,960	2,001–9,280
	5	51–232	251–1,160	501–2,320	751–3,480	1,001–4,640
VII		Numbers above group VI.				

[1] For fronts measured in metres reduce *observed* numbers by 10% before finding place in the above table.

It will be seen that each grade mean is 4·6 times the previous grade and the ratio of the 4th to the 1st and the 7th to the 4th is 100. The limits between these have been calculated and the general characteristics of each are as follows :—

Density I. Extremely thin. (1)—2·2 insects per 100 yards per minute. Up to about 2275 insects per mile front per hour. Only noticeable by careful watch by an expert.

Density II. Very thin. 2·3—(4·6)—10 insects per 100 yards per minute. About 2275—10,000 insects per mile front per hour. Should be seen by an expert and any careful naturalist on the look-out.

Density III. Thin. 10—(21·5)—46 insects per 100 yards per minute. Ten to fifty thousand per mile front per hour. Should be obvious to any observant field naturalist.

Density IV. Definite. 47—(100)—215 insects per 100 yards per minute. 50,000 to 227,000 per mile front per hour. Should be obvious to any normally observant individual.

Density V. Thick. 216—(464)—1000 insects per 100 yards per minute. 227,000 up to a million per mile front per hour. Obvious to the general public.

Density VI. Very thick. 1000—(2154)—4640 insects per 100 yards per minute. One to five million per mile front per hour. Gets into newspapers.

Density VII. Snowstorm. 4650—(10,000) or more insects per 100 yards per minute. Over five million per mile front per hour. "Stops motor cars." "Interferes with pedestrians." "Like a snowstorm." Newspaper headlines.

As observations are frequently taken over fronts of varying width and for varying periods of time I have drawn up in Table 37 the numbers for each grade to be observed crossing fronts of several different lengths in times from 1 minute to 20 minutes. From this any data given could rapidly be classified into the corresponding grade. If observations are taken on a front measured in metres the observed numbers must be reduced by 10% before comparing them with the table, as one yard is approximately 10% less than one metre.

It is recognised, of course, that none of the observations made in the field is really accurate. The front is seldom measured exactly, the time is often guessed, sometimes measured with an ordinary watch, and very seldom with a stop-watch, and finally the numbers counted get more and more inaccurate as the density increases. It is doubtful if more than 100 insects per minute can be counted with accuracy, so that in dense flights the front over which the count is made should be reduced to five or ten yards.

The other inaccuracies remain, but in view of the fact that in each group the maximum possible is over four times the minimum, a large error will have to be made before the wrong group is estimated. If a case is near the borderline it is probably of little practical importance to which group it is assigned.

The adoption of this system would give a greater definition to terminology and might enable more simple comparisons of intensity to be made, as has already been done with a similar classification of the British migrants by Cockbill (see p. 108).

XIII. Summary.

I. The report gives a general account of recent progress along various lines in the study of the migration of Lepidoptera particularly in the last ten years since the publication of Williams' *Migration of Butterflies* in 1930.

II. Among interesting early records of Butterfly Migration is an account of one seen in the year 1508 near Calais in France.

III. A detailed history of the abundance each year for over 100 years is given for about forty of the principal British Immigrant Butterflies and Moths.

A geometric scale is adopted and all species are graded each year in one of six levels of abundance, the scale for each species being in proportion to its maximum occurrence. As much as possible of the early literature has been examined and the records are believed to be sufficiently complete to justify discussion. A summary of the results will be found in Table 4 and figs. 1–4. The monthly distribution of most species has been worked out (Table 3) and in one or two it has been possible to show a relation between early appearance and abundance during the summer.

IV. An analysis of nearly 400 records of insects from ten lightships off the E. and S.E. coasts of Britain gave a list of 140 species of Lepidoptera of which 35 occurred on several occasions or in numbers which make it unlikely that their presence was accidental. Thirteen of these were known or suspected migrants. Others high up in the list were *P. meticulosa*, *A. monoglypha*, *E. similis* and *A. c-nigrum.* The flights were predominantly to the north and north-west from May to mid-August and to the east or south-south-east after mid-August.

V. Mr. and Mrs. Hodges of Florida made an almost continuous daily watch on the movement of butterflies for nearly two years. Their results are analysed. They show :—(1) a regular migration of *A. monuste* each year, at first to the south and then a sudden reversal of direction during May or June; (2) an almost continuous southerly movement of *P. eubule* and *T. lisa* at all times of the year; (3) regular movements to the north in spring, and/or autumn movements to the south in several other species, including *Danaus plexippus* and *D. berenice, Dione vanillae, Papilio cresphontes* and *Eudamus proteus.*

VI (1). The migrations of *D. plexippus* are discussed from several points of view. A study of geographical variations in America indicates a northerly migratory race in N. America; a southerly migratory race in S. America, south of the Amazon; and a non-migratory race between these two in the northern portion of S. America and many of the West Indian islands (fig. 18).

Downes observed the overwintering of *D. plexippus* in California and considers that most hibernating areas are very close to the sea and nearly all suitable spots are occupied to some extent. The males are sexually mature on emerging from the chrysalis in the autumn, pairing taking place throughout autumn, winter and spring; but the females do not normally mature eggs till the spring.

A large number of new records of migration for North and South America are discussed and figs. 20 and 21 summarise what is now known of the movements of this butterfly in N. America. A full list of the British and European records of appearance of *D. plexippus* is given, and a number have been examined, all except one of which are of the N. American race.

VI (2–11). Summaries are given of the present information on the migration of several other butterflies from America, Europe, Africa and Australia. Fig. 25 shows the known flights of *P. eubule* in the U.S.A. and West Indies. A regular to and fro movement is indicated. Plate 3 shows a migration of *Eunica monima* in progress in Mexico. A full account is given of recent extensive migrations of *Pieris brassicae* in England, including a flight at Harpenden that continued to the south for over three weeks. New records of *V. cardui* in West Africa indicate a definite migrating season south of the desert belt in September and October. New records are summarised for *Glycestha aurota, G. creona, G. java, C. florella* and several others.

VII. An account is given of some recent experiments in marking butterflies. Practically no recoveries have been made at a distance but much can be learnt from the rate of disappearance of the marked individuals from the locality of marking. A satisfactory technique is described. It is important to be able to distinguish individuals of the same species marked on the same date.

VIII. Orientation might possibly be by wind, sight, or perception of the earth's magnetic field. These three are discussed. It is shown that an individual insect might determine the direction of the wind without the use of sight, but that there is no evidence that the direction of the wind determines the direction of migration. Recent work on orientation by sight is discussed in relation to migration. Experiments on young locusts showed no evidence of appreciation of a powerful magnetic field.

IX. Evidence for the occurrence of a return flight in migrant Lepidoptera is shown to be increasing. The question of the fundamental difference between migrations with and without a return flight is reviewed, and the evolutionary difficulty of the persistence of migration without a return flight is emphasised.

X. A significant positive correlation between the occurrence in unusual numbers of *V. cardui* in Europe and N. America is shown to exist. This supports the similar results previously obtained from *C. lineata*.

XI. Intercorrelations between 35 British Immigrant Lepidoptera have been calculated and discussed. The average correlation is slightly positive (+ 0·12). By sorting the species it has been possible to find several groups the members of which are positively correlated within their own groups, but usually negatively correlated with other groups (Table 34). The first of them is quite definite and contains fifteen closely associated species. The second is less definite. Group 7 contains five species and Group 8 the three *Pieris* species. To a certain extent the grouping follows the geographical range of the species.

The average frequency of the principal groups each year for 78 years is given in fig. 60 and shows no evidence of periodicity.

XII. A classification is suggested of the density of any flight as measured by the number of insects crossing a definite front in a definite time. This is a series of seven grades the numbers in which are in geometric proportion.

XIV. The Bibliography includes all references to the migration of butterflies that have been traced in the past ten years and which are not included in the previous Bibliography given in Williams 1930b.

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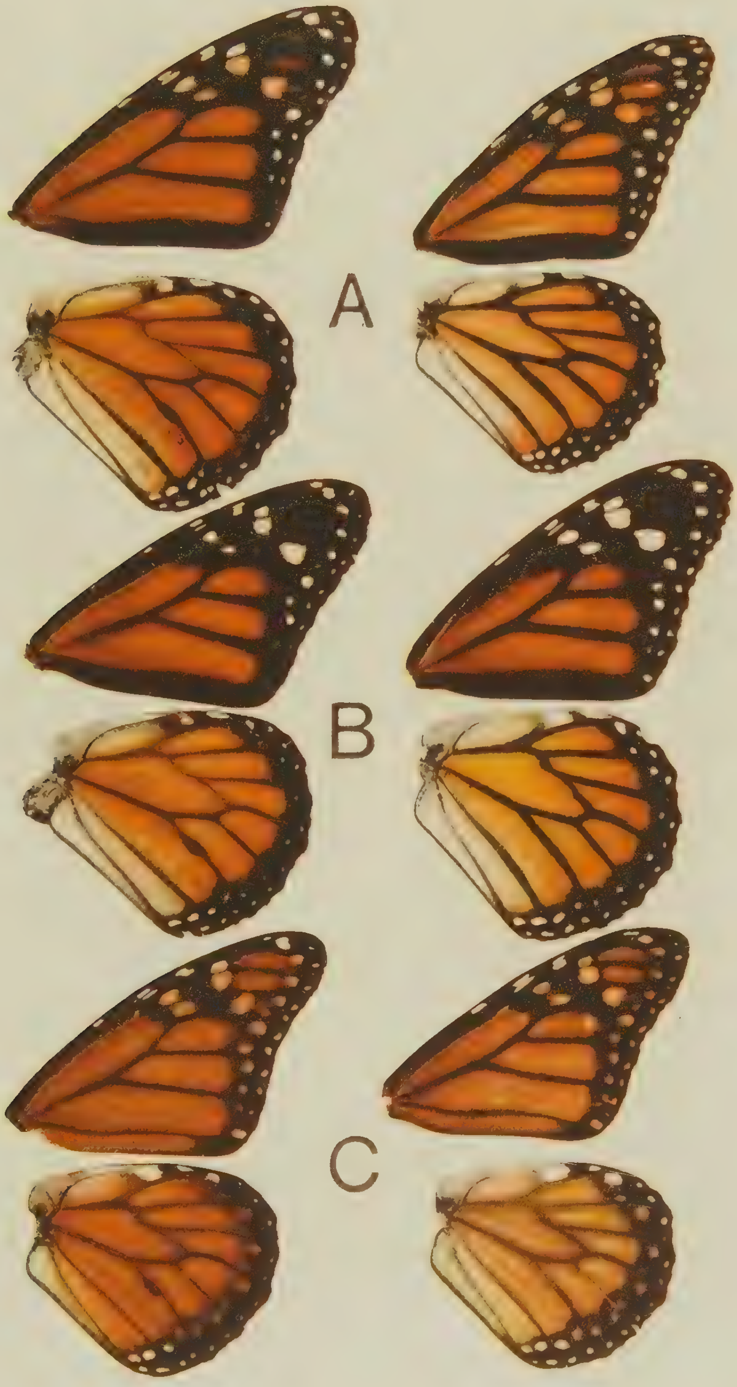
Plate 1.

The geographical races of *Danaus plexippus*, males to left, females to right :—A, the North American form *D. plexippus plexippus* ; B, the Central American form *D. plexippus nigrippus* ; C, the South American form *D. plexippus erippus.*

Plate 2.

Fig. 2. Monarchs hibernating at Pacific grove in the winter of 1938–39. Photo by J. A. Downes.

3. *Eunica monima* migrating in Mexico in June 1940. Photo by D. B. Legteres.



Geographical races of *Danaus plexippus*.

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3

ENGRAVED BY STAR ILLUSTRATION, LONDON

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